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CONTENTS

OPENING SESSION

WELCOMING ADDRESS, Dante B. Fascell 7

OPENING ADDRESS, Richard A. Kahn 8

ECONOMIC SESSION

SOME ECONOMIC ASPECTS OF THE SOUTHERN SHRIMP FISHERY, W. H. Stolting 21

TRADE RELATIONS OF NORWAY WITH THE GULF AND CARIBBEAN AREA, Magne Oppedal 31

THE INTEREST OF THE OFFICE OF PRICE STABILIZATION IN SOUTHERN SPECIES OF FISH, William Eardley 33

WHAT ARE THE MAJOR PROBLEMS OF THE FISHERIES? . . . 34
Harden F. Taylor

NORTHERN MARKETS FOR SOUTHERN SEAFOODS 39
Spencer A. Larsen

SHELL FISHERIES SESSION

WINTER GROWTH OF THE AMERICAN OYSTER *Crassostrea virginica* IN APALACHICOLA BAY, FLORIDA 46
Robert M. Ingle and Charles E. Dawson, Jr.

REPORT ON THE ATTEMPTED INTRODUCTION OF THE VIRGINIA OYSTER *Crassostrea virginica* INTO THE WATERS OF PUERTO RICO, N. T. Mattox 46

A CRITICISM OF OYSTER MEASUREMENTS, G. Robert Lunz . . 48

GROWTH RATE AND MOVEMENTS OF HARD CLAMS, *Venus mercenaria*, A. F. Chestnut 49

SEXUAL DIMORPHISM IN WEIGHT AND LENGTH RELATIONSHIPS OF THE BERMUDA SPINY LOBSTER . . 59
Edwin P. Creaser

SOME OBSERVATIONS OF THE BREEDING AND MIGRATION OF THE BERMUDA SPINY LOBSTER, *Panulirus argus* 64
W. H. Sutcliffe, Jr.

A PRELIMINARY REPORT ON THE BIOLOGY AND ECONOMICS OF THE SPINY LOBSTER IN PUERTO RICO, N. T. Mattox . . 69

GROWTH AND MORTALITY RATES IN SIBLING AND UNRELATED OYSTER POPULATIONS, Philip A. Butler . . . 71

HEXAMITIASIS OF *Ostrea edulis L.* AND *Crassostrea virginica* (GMELIN), J. G. Mackin, P. Korringa, and S. H. Hopkins . . .

COMMERCIAL FISHERIES SESSION

HOW CAN SALES OF SOUTHERN FISH BE IMPROVED IN NORTHERN MARKETS, Frank W. Wilkisson . . . . . .

THE DEVELOPMENT OF THE BROWNSVILLE SHRIMP INDUSTRY, W. L. Hardee . . . . . .

BREADED SHRIMP, Lawrence W. Strasburger . . . . . .

FISHERY EXPLORATION AND TECHNOLOGY SESSION

STUDIES ON BLACKSPOTTED SHRIMP, E. A. Fieger . . . . .

FREEZING SHRIMP AT SEA, Harold E. Crowther . . . . . .

EXPLORATORY FISHING FOR THE LITTLE TUNA *Euthynnus alletteratus* OFF THE ATLANTIC COAST OF THE UNITED STATES, Carl B. Carlson . . . . . .

STUDIES OF THE "TRASH" CAUGHT BY SHRIMP TRAWLERS IN FLORIDA, J. B. Siebenaler . . . . . .

METHODS OF CAPTURING FLYING FISH, D. W. Wiles . . . .

THE GEAR DEVELOPMENT PROGRAM OF THE M/V "OREGON," Harvey R. Bullis, Jr. 1

CARIBBEAN AND GENERAL SESSION

OCEANOGRAPHIC INSTRUMENTS, THEIR USE AND APPLICATION IN MARINE BIOLOGY 1
A. W. Anderson and John Lyman

FISH CULTURE PROJECT IN HAITI, S. Y. Lin 1

SPORT FISHES OF THE VICINITY OF THE GULF OF HONDURAS, CERTAIN CARIBBEAN ISLANDS, AND CARMEN, MEXICO . 1
Frank J. Mather III

EARLY EXPLORATION IN THE GULF OF MEXICO, Paul S. Galtsoff

THE ACTIVITIES OF THE GULF STATES MARINE FISHERIES COMMISSION, OCTOBER 1950—OCTOBER 1951 1
W. Dudley Gunn

ACTIVITIES OF THE ATLANTIC STATES MARINE FISHERIES COMMISSION, Wayne D. Heydecker 3

THE EFFECT OF FLUCTUATIONS IN THE AVAILABILITY OF SHARKS ON A SHARK FISHERY, Stewart Springer 4

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MONDAY—NOVEMBER 12

Welcoming Address

DANTE FASCELL
Representative, Dade County, Florida State Legislature.

I AM VERY HAPPY to extend to you a warm welcome of the State of Florida, Greater Miami, and the University of Miami to this fourth annual session of the Fisheries Institute.

It is pleasing and impressive to discover the great cooperative effort which goes to make up these proceedings. Too often nowadays, because of the speed of living and the complexity of our governments, we find cooperative organization difficult to achieve and maintain.

The cue might well be taken in the solution of other world problems, that here we have the combined talents, efforts and abilities of scientists, government officials, educational leaders and members of the world's oldest and perhaps most important industry. The cohesive force which brings all of you here will live on in your reports, activities and proceedings to inspire others who shall follow in your footsteps.

We are honored to have this regional program continue to take on an important international flavor. The representatives of the governments of the Netherlands, Pakistan, Norway, Puerto Rico, Bermuda, Haiti, Martinique, The Bahamas, Barbados, Cuba and our own United States are most welcome. We thank them for the gracious assistance they have given.

In fact so many persons and institutions have contributed to the success of these meetings that I would have to name and thank each one of you. All of you have contributed to a program which on my inspection looks varied, ambitious and interesting. I take the liberty to note only one deficiency. There is to be no paper or panel on the most important subject of "Augmented Techniques of Measuring and Studying State Legislators." Everything else seems to be more than adequately explored. I am quick to assure you, however, that Florida joins with the other Gulf states in supporting and advancing the vital work which will be carried on here this week.

I am sure that Dr. Richard A. Kahn of the Defense Fisheries Administration, Mr. Richard Whiteleather of the U. S. Fish and Wildlife Service, Mr. George Vathis of the Florida State Board of Conservation, and Dr. F. G. Walton Smith of the Marine Laboratory of the University of Miami, and their associates have put in many tiring hours and days in Congress and in the Legislative halls of this state giving the Congress and the Legislature a composite picture of the important work being done by the Institute and its members. We are hopeful that because of their untiring efforts and the help of many more like them in their respective states and countries that improved assistance and even better relations can be achieved.

On behalf of the University of Miami and its Marine Laboratory, Greater

Miami, the local fish industry, and the State of Florida we bid all of you welcome. May your work be profitable and enjoyable; your determination stronger and your stay most pleasant. By all means come back again, we are very happy to have all of you here.

Opening Address

RICHARD A. KAHN

Chief, Branch of Economic Facilities, Defence Fisheries Administration, Washington, D. C.

WHEN I HAD THE HONOR of delivering the opening address in 1948, at the first meeting of the Gulf and Caribbean Fisheries Institute, the hope was expressed that enlightenment would radiate from this new enterprise, established in the United States, all over the countries and nations which comprise the Gulf and Caribbean area. International trade of fish and fishery products in this area has developed in the last three years and this enrichment of international trade has been due, to a large extent, to interest in the Gulf and Caribbean area brought about by this Institute.

Detailed figures on the United States trade with the Gulf and Caribbean area will be found at the end of this paper.

Exports of canned salmon from the United States to six Gulf and Caribbean countries consisting of Mexico, Panama, Cuba, Haiti, Dominican Republic and Columbia, increased from about 162,000 pounds in 1948 to about 344,000 pounds in 1950. More than half of these went to Mexico. Exports of canned sardines to fourteen countries in the Gulf and Caribbean area increased from about 4,700,000 pounds in 1948 to about 17,300,000 pounds in 1950. More than half of them went to Cuba, about 2,500,000 pounds were exported to Venezuela, a great fish producing country itself. About a million pounds of canned mackerel were exported in 1950 to Salvador. Salvador is in the Gulf area, but not located at the Gulf. Among the imports from Gulf and Caribbean countries to the United States, imported Mexican shrimp increased 77% from about 22,000,000 pounds in 1948 to about 39,000,000 in 1950. Other species however, show more perplexing figures. Imports of canned spiny lobsters from Cuba increased by 144% from 294,000 pounds in 1948 to 719,000 pounds in 1950. Clams, fresh or frozen, imported from Mexico increased from about 307,000 pounds in 1949 to about 827,000 pounds in 1950. The imports of fresh or frozen tuna from Cuba to the United States, still small in absolute figures, increased more than ten times in the three years. In 1950 182,000 lb were imported. Imports of fishery products, considered specialties of the Gulf and Caribbean, such as spiny lobsters (not canned) and turtles remained relatively unchanged; about 500,000 pounds from the Bahamas, about 1,000,000 pounds from Cuba, about 300,000 from Mexico were imported.

The production figures within the Gulf and Caribbean area are not as satisfactory as the international trade figures are. The phenomenal development of the shrimp fisheries in the United States and Mexico cannot be considered as normal evolution of local fisheries for domestic consumption needs. While the production of fishery products per fisherman in the United States-Gulf area on the basis of 1947 figures is 24,577 pounds (including 8,722 pounds non-food fish), the production in the other independent countries of the Gulf area

Caribbean area is about 3,650 pounds and in the dependent countries of the Gulf and Caribbean about 1,880 pounds, on the basis of figures published by the Food and Agriculture Organization of the United Nations. The production per capita of the population in the Gulf States of the United States from the Gulf-Caribbean area is about 30.1 pounds fish in the round (including 11.4 non-food fish), in the other independent countries 6.6 pounds round weight; and in the dependent territories, about 10.1 pounds, round weight.

It was known when this Institute was established that the population of the Gulf and Caribbean area outside the United States suffers from insufficient domestic fish production. However, as Goethe said: "The truth requires constant repetition because error is preached about us all the time." The truth is that more fish at reasonable prices must be made available to the peoples of the Gulf and Caribbean area in the interest of their physical development. Many ways and means of accomplishing this have been discussed in earler meetings of this Institute.

Dr. F. G. Walton Smith in his welcoming address in 1948 mentioned the fact that the Institute, by bringing together biologists, processors, technologists and economists, is actually universal in its character. Let me develop somewhat further this idea of universality. It is expressed also in the fact that this Institute is part of a university. The name university itself indicates that this is an institute where *all* arts and sciences are taught. This is not the only meaning of the word university. It means also that *all* sciences and arts should be included in the knowledge of those who graduate from the university. The true student should be universal and liberal in his education and also in his character. That does not mean that he should add in his mind innumerable details of knowledge, but he should have a broad concept of all the knowledge of his time and he should acquire such knowledge the liberality and the nobility of spirit, which is broadmindedness towards all and everybody. Universality and liberality in education brings about a certain morality of character which makes for easy understanding of different religions, different languages and different races. When I look towards the development of my own art namely, political economy, I should remember that the founder of this art of political economy was a professor of moral philosophy in Glasgow, Adam Smith. The science which is the concern of most of you here namely, biology, was, until the turn of the century, 1900, included in the curriculum of the Departments of Philosophy. We do not have to excuse ourselves if we, as economists or biologists, again become philosophical and universal. That is what the spirit of the university requests from us, and that is just what we want to do. Let us have this great idea of a broad education in mind when we proceed in our separate sessions namely; the commercial session, the shellfish session, the economic session, the technology session, and the Caribbean session. All these sessions should be held in the spirit of universality. If we follow this line of thinking, we will tend to liberalize our minds and to come to a real enjoyment of this exceptionally fine place, in which we are assembled. Let me close with the great words of Aristotle, "Of possessions," he says, "those rather are useful, which bear fruit; those liberal, which tend to enjoyment. By fruitful, I mean those which yield revenue; by enjoyable, where nothing accrues of consequence beyond the using." What we acquire here during the next days will be useful as well as liberal possessions, in the meaning of Aristotle. For many the acquisition of knowledge on possible exports, on technological developments and on exploratory fishing should be fruitful. But to all of us the new acquisition of some more knowledge should be enjoyable in the meaning of the philosopher, because

nothing accrues of consequences beyond the acquisition. In this way we co
tribute to the liberal and universal education, which so successfully is pursue
by the University of Miami.

U. S. FOREIGN TRADE WITH GULF AND CARIBBEAN AREAS

I. Exports from the United States to Countries of the Gulf and Caribbean Areas.

Item	1948	1949	1950
	lbs.	lbs.	lbs
Bahamas			
Fish, nes, fresh or frozen	9,699	10,633	3,119
Oysters, shucked, fresh or frozen	....	....	230
Shrimp, fresh or frozen	200	....	753
Fish, smoked or kippered	....	295	1,489
Salmon, canned	4,805	421	444
Sardines, canned, inc. pilchards	3,049	....	1,125
Fish, canned, nes, ex. shellfish	1,189	72	7,435
Clams, canned	....	510	...
Salmon, fresh or frozen	449	....	...
Shrimp, salt, pickled, dried, cured	100	....	...
Salmon, salt, pickled, dried, cured	265	....	...
Herring, canned	367	....	
Shrimp, canned	102	....	...
Fish and prod. ed. nes	2,114	....	...
Barbados			
Shrimp, fresh or frozen	....	....	528
Shrimp, canned	280	....	...
Bermuda			
Salmon, fresh or frozen	3,173	1,529	633
Cod, haddock, fresh or frozen	....	2,315	400
Fish, n. e. class., fresh or frozen	2666	3,023	3,134
Oysters, fresh or frozen, in shell	....	1,400	...
Shrimp, fresh and frozen	4,629	4,027	11,644
Lobster, fresh and frozen	795	....	695
Shellfish, n. e. class., fresh or frozen	....	220	1,545
Fish, smoked or kippered	....	201	393
Salmon, canned	17,432	....	1,440
Sardines, canned, incl. pilchard	2,310	450	180
Crabs, crab meat, canned	2,755	3,996	...
Clams, fresh or frozen	100	800	...
Tuna, canned	....	16,301	...
Fish, nes, canned, except shellfish	11,087	717	...
Shrimp, canned	6,058	3,630	30
Shellfish, pres., prep., nes	....	80	...
Oysters, fresh, frozen, shucked	1,572	....	...
Cod, haddock, hake, etc., salt., pickled, dried, cured	200	....	...
Fish, nes, salt., pickled, dried, cured	200	....	...
Herring, canned	600	....	...
Lobster, canned	53	....	...
Clams and oysters, canned	150	....	...
Crabs, fresh or frozen	300	....	...
Fish and prod, ed., nes	5,370	....	...
British Guiana			
Sardines, canned, inc. pilchards	....	58,425	...

British Honduras			
Salmon, canned	630	....	310
Sardines, canned, inc. pilchards	2,250	....	8,330
Fish and prod. ed., nes	205	....	....
Canal Zone, Panama			
Salmon, fresh or frozen	8,917	15,200	990
Cod, haddock, etc., fresh or frozen	....	86,510	12,698
Fish, fresh or frozen, n.e. class.	190,075	54,457	23,090
Oysters, shucked, fresh or frozen	7,968	13,230	6,637
Shrimp, fresh or frozen	50,458	34,400	3,462
Lobsters, fresh or frozen	6,625	2,620	940
Shelfish, fresh or frozen, n.e. class.	....	7,805	4,750
Cod, haddock, salt., or pickled, dried, cured	634,244	526,649	361,334
Herring, salt. or pickl.	1,650	16,890	750
Fish, salt. or pickl., n.e. class.	105,612	24,850	12,000
Fish, smoked or kippered	....	1,845	3,670
Salmon, canned	109,300	....	48,404
Sardines, canned, incl. pilchards	123,610	71,118	110,342
Cod, haddock, hake, etc., canned	338	1,600	500
Tuna, canned	....	19,123	32,554
Fish, canned, n. e. class.	13,894	9,832	11,148
Shrimp, canned	8,525	9,501	4,017
Crab and crab meat, canned	3,390	2,116	1,434
Oysters, canned	....	4,233	1,472
Fish, prep., pres., n.e. class.	....	2,600	640
Shellfish, prep., pres., n.e. class.	....	....	165
Clams, fresh or frozen	944	300	....
Salmon, salt., pickle., dried, cured	....	1,940	....
Herring, canned	6,928	1,640	....
Mackerel, canned	....	1,200	....
Clams, canned	....	6,181	1,846
Oysters, fresh (in shell)	3,200	....	....
Lobsters, canned	1,555	....	....
Clams and oysters, canned	8,630	....	....
Crabs, fresh or frozen	573	....	....
Fish and prod. ed. nes	58,178	....	....
Colombia			
Herring, salted, pickled, dried, cured	11,245	45,150	10,967
Salmon, canned	111,584	30,102	173,034
Sardines, canned, inc. pilchards	197,284	992,157	2,274,845
Cod, haddock, hakes, etc., canned	....	....	3,000
Tuna, canned	....	12,793	62,275
Mackerel, canned	....	5,430	2,475
Fish, canned, nes, except shellfish	366,116	2,671	8,879
Shrimp, canned	12,963	9,850	32,979
Crabs and crab meat, canned	2,274	2,270	783
Oysters, canned	....	3,128	4,815
Clams, canned	....	1,047	705
Fish, nes, fresh or frozen	1,250	....	....
Cod, had., hake, etc., salt., pickle., cured	1,077	....	....
Herring, canned	2,061	....	....
Lobsters, canned	1,290	....	....
Oysters and clams, canned	4,553	....	....
Shellfish, nes, canned	2,487	....	....
Fish and prod. ed., nes	7,772	....	....

Costa Rica			
Cod, haddock, etc., salt., pickle., dried, cured	5,000	....	550
Shrimp, salt., pickle., dried, cured	1,414	2,500	1,930
Salmon, canned	27,513	2,466	7,590
Sardines, canned, inc. pilchards	478,708	611,429	1,322,884
Cod, haddock, hake, etc., canned	450	....	330
Fish, canned, nes., exc. shellfish	48,688	1,200	1,357
Shrimp, canned	4,556	2,577	2,967
Oysters, canned	....	805	808
Mackerel, canned	....	1,350	....
Crabs, crab meat, canned	537	97	....
Oysters, fresh, frozen, shucked	88	....	....
Shrimp, fresh or frozen	450	....	....
Herring, salt., pickle., dried, cured	2,300	....	....
Sardines, salt. ,pickle., dried, cured	2,250	....	....
Herring, canned	1,325	....	....
Clams and oysters, canned	3,110	....	....
Fish and prod. ed., nes	3,430	....	....
Cuba			
Salmon, fresh and frozen	13,011	1,578	535
Cod, haddock, fresh and frozen	....	....	2,540
Fish, n.e. class, fresh and frozen	34,925	22,388	30,034
Shrimp, fresh and frozen	12,452	10,554	21,000
Shellfish, n.e. class, fresh and frozen	....	16,096	19,290
Salmon, salted, pickle., or cured	....	....	480
Cod, haddock, salted, pickle., dried, cured	4,764	51,640	6,348
Herring, salted, pickled, dried, cured	58,627	37,457	36,532
Fish, n.e. class., salted or pickled	2,214	2,831	7,122
Shrimp, salted, pickled, dried or cured	161,643	131,462	261,564
Shellfish, n.e. class, salted or pickled	....	7,500	1,380
Salmon, canned	7,909	16,514	82,750
Sardines, canned, incl. pilchards	3,061,293	5,001,950	9,458,331
Herring, canned	7,752	....	4,214
Tuna, canned	....	....	20,001
Mackerel, canned	....	45,540	20,550
Fish, canned, n.e. class.	197,579	60,959	98,159
Shrimp, canned	51,554	36,882	77,179
Crabs and crab meat, canned	400	216	280
Oysters, canned	....	435	1,270
Shellfish, canned, n.e. class.	36,282	97,643	167,849
Fish, prepared and pres., n.e. class	....	420	180
Oysters, fresh or frozen (in shell)	3,810	555	370
Clams and oysters, canned	686	....	....
Clams, fresh or frozen	990	....	....
Fish and prod. ed. nes	118,006	....	....
Dominican Republic			
Fish, nes, fresh or frozen	....	620	616
Shrimp, fresh or frozen	375	....	300
Cod, haddock, etc., salt., pickled, dried, cured	600	....	19,300
Herring, salt., pickle., dried, cured	....	1,000	160
Salmon, canned	6,782	25,200	14,697
Sardines, canned, inc. pilchards	24,175	20,243	78,940
Herring, canned	....	....	18,000
Tuna, canned	....	1,185	1,605
Fish, canned, nes. exc. shellfish	1,845	66	1,086

Shrimp, canned	750	1,500	5,778
Oysters, canned	....	97	97
Shellfish, nes, fresh or frozen	....	110	....
Shrimp, salted, pickled, dried, cured	....	200	....
Crab, crab meat, canned	113	959	....
Fish, nes., salted, pickled, dried, cured	3,900	....	....
Clams and oysters, canned	173	....	....
Fish and prod. ed., nes	73,827	....	....
FRENCH WEST INDIES			
Salmon, canned	....	....	2,726
Fish, canned nes., class., exc. shellfish	2,400	....	....
GUATEMALA			
Fish, fresh, frozen, n.e. class.	3,000	300	300
Oysters, shucked, fresh or frozen	5,622	304	340
Shrimp, fresh or frozen	450	3,010	4,035
Cod, haddock, hake, salted or pickled, dried, cured	11,600	16,320	13,028
Herring, salted, pickled, dried, cured	400	300	275
Fish, salted, pickled, dried or cured n.e. class.	....	500	500
Salmon, canned	9,778	16,665	10,298
Sardines, canned, inc. pilchards	289,744	967,743	1,184,830
Herring, canned	....	....	280
Tuna, canned	....	781	1,586
Fish, canned, n.e. class.	20,954	3,944	355
Shrimp, canned	6,626	8,582	9,511
Crab and crab meat, canned	842	285	701
Oysters, canned	....	2,606	2,232
Shellfish, canned, n.e. class.	558	2,592	570
Lobsters, fresh or frozen	....	220	....
Shrimp, salted, pickled, dried, cured	....	620	710
Cod, haddock, hake, canned	2,340	800	....
Mackerel, canned	....	600	....
Clams and oysters, canned	2,528	....	....
Fish and prod., nes. ed.	2,768	....	....
HAITI			
Fish, nes., fresh or frozen	200	....	236
Shellfish, nes., fresh or frozen	....	....	360
Salmon, salted, pickled, dried or cured	200	....	400
Fish, nes., salted, pickled, dried, or cured	1,000	....	800
Salmon, canned	2,880	6,072	5,424
Sardines, canned, inc. pilchards	4,695	4,792	10,724
Fish, canned, nes., exc. shellfish	63	....	140
Cod, haddock, dried, cured, salted, pickled	....	510	....
Fish, smoked or kippered	....	6,048	....
Herring, salted, pickled, dried, cured	134,584	....	....
Shrimp, canned	84	....	....
Fish and prod. ed., nes	66,340	....	....
HONDURAS			
Cod, haddock, fresh or frozen	....	....	240
Cod, haddock, salted or pickled, dried, cured	860	1,760	1,374
Herring, salted or pickled	....	1,326	1,305
Shrimp, salted or pickled	210	944	3,037
Salmon, canned	15,081	8,464	5,352
Sardines, canned, inc. pilchards	124,865	308,877	344,950
Tuna, canned	....	....	630

Mackerel, canned	....	....	700
Fish, canned, n.e. class.	6,907	15,140	1,313
Shrimp, canned	3,847	3,174	1,999
Oysters, shucked, fresh or frozen	1,325	1,710	....
Shrimp, fresh or frozen	....	262	....
Salmon, salted, pickled, dried, or cured	....	113	....
Cod, haddock, hake, etc., canned	....	390	....
Herring, canned	250	1,015	....
Shellfish, nes., canned	....	900	....
Crabs, crab meat, canned	192	....	....
Clams and oysters, canned	448	....	....
Fish and prod., nes. ed.	801	....	....
JAMAICA			
Salmon, canned	1,506	3,027	1,711
Sardines, canned, inc. pilchards	....	142	94,237
Tuna, canned	....	402	234
Fish, canned, nes. exc. shellfish	....	52	379
Crabs and crab meat, canned	....	97	112
Herring, canned	....	250	....
Shrimp, canned	....	150	....
Salmon, salted, pickled, dried, cured	2,000	....	....
Fish and prod. ed., nes	720	....	....
LEEWARD ISLANDS			
Tuna, canned	....	516	200
Shrimp, canned	....	....	100
Fish, canned, nes., exc. shellfish	....	123	....
Cod, haddock, hake, etc., salted, pickled, dried, cured	480	....	....
MEXICO			
Salmon, fresh or frozen, exc. canned	150	....	400
Cod, haddock, fresh or frozen	....	....	1,000
Fish, nes, fresh or frozen	20,857	10,917	20,328
Oysters	....	....	525
Shrimp, fresh or frozen	18,865	13,150	6,215
Clams, fresh	....	....	1,920
Lobsters, fresh and frozen	1,600	3,612	2,938
Salmon, salted, pickled, cured	1,125	....	192
Cod, haddock, hake, salted, pickled, cured	1,000	14,300	2,550
Herring, salted, pickled, dried, cured	28,245	....	27,150
Fish, nes, dried, cured	23,203	650	....
Shellfish, nes.	....	....	700
Fish, smoked, nes.	....	....	5,978
Salmon, canned	8,381	8,720	18,395
Sardine, canned, inc. pilchards	39,675	56,653	150,813
Cod, haddock, canned	....	....	1,100
Tuna, canned	....	300	400
Fish, canned, nes.	13,298	6,684	18,300
Crab and crab meat, canned	4,758	1,803	584
Oysters, canned	....	....	...
Shellfish, canned, nes.	23,985	....	7,42
Fish prod., nec.	....	1,200	60
Shellfish, pr., nec	....	....	...
Fish, pr., nec.	....	21,367	...
Shrimp, salted, pickled, dried, cured	2,454	....	...
Sardines, salted, pickled, dried, cured	2,736	....	...
Shrimp, canned	228	....	...
Fish and prod. ed., nes.	21,367	....	...

NETHERLAND'S ANTILLES			
almon, fresh or frozen	4,308	8,297	3,039
od, haddock, fresh or frozen	....	32,902	11,225
ish, fresh or frozen, n.e. class.	17,920	19,610	18,272
ysters, fresh or frozen, shucked	1,325	740	108
hrimp, fresh or frozen	7,061	10,184	26,961
obsters, fresh or frozen	60	600	1,492
hellfish, fresh or frozen, n.e. class.	....	975	2,650
almon, salted, pickled, or cured	29,315	24,430	23,325
od, haddock, etc., salted, pickled., dried, cured	110,317	76,006	53,579
lerring, salted, pickled	9,200	2,100	3,400
ish, salted, pickled, n.e. class.	15,200	12,965	5,418
hrimp, salted, pickled or cured or dried	23,790	26,155	17,485
ish, smoked or kippered	....	10,203	8,800
almon, canned	156,364	193,347	176,276
ardines, canned, inc. pilchards	59,403	36,149	123,966
lerring, canned	1,177	....	5,190
una, canned	....	5,412	5,790
ish, canned, n.e. class.	6,423	935	3,730
hrimp, canned	32,383	26,511	42,072
rabs and crab meat, canned	12,491	3,236	2,651
ysters, canned	....	1,768	2,031
ish, prep. pres. n.e. class	....	240	450
hellfish, nes., salted, pickled, dried, cured	....	200	....
ysters, fresh (in shell)	3,888	....	....
od, haddock, hake, etc., canned	735	....	....
obsters, canned	4,684	....	....
lams and oysters, canned	8,133	....	....
hellfish, nes., canned	624	....	....
ish and prod. ed. nes.	55,059	....	....
NICARAGUA			
od, haddock, etc., salted, pickled, dried, cured	....	....	240
almon, canned	14,931	6,421	15,738
ardines, canned, inc. pilchards	47,178	7,866	12,913
una, canned	....	1,615	2,737
ish, canned, nes. exc. shellfish	2,446	338	204
rimp, canned	2,017	1,755	3,351
rabs and crab meat, canned	140	....	177
ysters, canned	....	640	635
ish, fresh, frozen, nes. class. exc. canned	300	....	....
rimp, fresh or frozen	265	....	....
rimp, salted, pickled, dried, cured	200	....	....
ardines, salted, pickled, dried, cured	480	....	....
od, haddock, hake, canned	680	....	....
lams and oysters, canned	751	....	....
ish and prod. ed. nes.	60	....	....
PANAMA			
od, haddock, fresh or frozen	....	....	240
rimp, fresh or frozen	904	1,848	700
almon, salted and pickled, dried, cured	....	200	700
erring, salted and pickled	144	1,199	3,764
rimp, salted, pickled, or cured	59,015	81,124	90,179
ish, smoked or kippered	....	367	906
almon, canned	22,080	62,167	34,261
ardines, canned, incl. pilchards	132,709	404,147	713,324

Tuna, canned	....	3,438	6,818
Fish, canned, n.e. class.	9,576	2,356	383
Oysters, canned	....	840	140
Shellfish, canned, n.e. class.	1,560	2,264	1,200
Fish, nes., fresh or frozen	10,669	4,800	....
Oysters, shucked, fres hor frozen	414	720	....
Herring, canned	180	338	....
Shrimp, canned	8,508	7,498	9,912
Crabs, crab meat, canned	120	465	....
Fish, nes., salted, pickled, dried, cured	16,889	....	....
Clams and oysters, canned	1,450	....	....
Fish and prod. nes. ed.	2,717	....	....
SALVADOR			
Cod, haddock, hake, etc., salted, pickled, dried, cured	6,820	7,240	3,500
Herring, salted, pickled, dried, cured	....	332	420
Shrimp, salted, pickled, dried, cured	....	....	1,000
Salmon, canned	3,008	10,558	17,463
Sardines, canned, inc. pilchards	50,666	188,475	119,530
Cod, haddock, hake, etc., canned	....	1,400	4,800
Tuna, canned	....	357	566
Mackerel, canned	....	608,515	992,205
Fish, canned, nes. exc. shellfish	216,561	141,268	330,732
Shrimp, canned	606	953	2,602
Crabs, crab meat, canned	344	994	1,907
Oysters, canned	....	382	387
Cod, haddock, etc., fresh or frozen	....	5,850	...
Fish, nes., fresh or frozen	....	4,800	...
Lobsters, fresh or frozen	....	150	...
Oysters, fresh, frozen (shucked)	110	....	...
Fish and prod. nes. ed.	180	....	...
SURINAM			
Salmon, canned	31,258	48,485	23,62
Sardines, canned, inc. pilchards	80,485	255,048	309,63
Shrimp, canned	....	85	34
Crabs and crab meat	....	495	36
Herring, salted, pickled, dried, cured	....	6,165	...
Tuna, canned	....	190	...
Shrimp, fresh or frozen	1,160	....	...
Salmon, salted, pickled, dried, cured	10,500	....	...
Fish and prod. ed. nes.	223	....	...
TRINIDAD			
Sardines, canned, inc. pilchards	....	....	4,50
Shrimp, canned	....	....	3
Tuna, canned	....	135	..
Fish, canned, nes. exc. shellfish	294	117	..
Salmon, canned	886	....	..
Crabs, crab meat, canned	113	....	..
Shellfish, nes., canned	1,100	....	..
VENEZUELA			
Salmon, fresh or frozen	5,589	816	4,2
Cod, haddock, fresh or frozen	....	34,327	21,2
Fish, fresh or frozen, n.e. class.	98,717	44,234	53,7
Oysters, fresh or frozen (in shell)	8,339	26,425	3,8
Oysters, fresh or frozen (shucked)	2,756	2,493	2,6
Shrimp, fresh or frozen	13,969	20,933	32,6
Lobsters, fresh or frozen	336	448	1,7

Shellfish, fresh or frozen, n.e. class.	....	30,976	48,529
Salmon, salted, pickled, dried, or cured	960	....	330
Cod, haddock, salted, pickled, dried, cured	731	21,830	32,112
Herring, salted or pickled	25,890	26,451	43,217
Shrimp, salted, pickled, or cured	5,417	5,683	2,050
Shellfish, salted, pickled, n.e. class.	....	....	230
Fish, smoked or kippered	....	13,778	5,961
Salmon, canned	365,092	473,717	97,650
Sardines, canned, inc. pilchards	211,593	879,781	2,141,287
Cod, haddock, hake, canned	4,245	2,940	270
Tuna, canned	..	244,857	140,535
Fish, canned, n.e. class.	151,717	83,789	26,629
Shrimp, canned	175,785	201,056	146,395
Crab and crab meat, canned	9,404	11,891	2,972
Oysters, canned	....	22,012	8,922
Clams, canned	....	1,485	2,337
Shellfish, canned, n.e. class.	19,725	5,085	6,046
Fish, prep. pres. n.e. class.	....	4,975	420
Fish, nes. salted, pickled, dried, cured	300	3,137	750
Herring, canned	14,364	3,183	....
Lobsters, canned	7,388	....	....
Clams and oysters, canned	17,249	....	....
Fish and prod. ed. nes.	53,577	....	....

U. S. FOREIGN TRADE WITH GULF AND CARIBBEAN AREAS

II. Imports to the United States from Countries of the Gulf and Caribbean Areas

Item	1948	1949	1950
	lbs.	lbs.	lbs.
Bahamas			
Tuna, fresh or frozen	....	1,000	900
Halibut, salmon & fresh-water fish	....	452	....
Fish filleted, etc., nes, fresh or frozen	120	1,003	....
Shark fins, dried and unsalted	2,329	787	470
Fish whole, etc., nes, fresh or frozen	285,125	350,850	337,939
Lobster, not canned	1,197,821	1,297,857	1,289,496
Turtles	5,833	4,792	8,488
Clams, fresh or frozen, not airtite	....	....	6,000
Shellfish, nes	72,925	73,006	60,871
British Honduras			
Fish filleted, etc., nes, fresh or frozen	5,122	....	2,900
Shark fins, dried and unsalted	....	200	....
Fish whole, etc., nes, fresh or frozen	40,611	....	....
Lobster, not canned	136,263	53,110	83,168
Shrimp and prawns	192	....	....
Shellfish, nes	235	....	....
Canal Zone, Panama			
Tuna fish, in oil	4,815	....	....
Shrimp and prawns	....	1,200	148,250
Colombia			
Tuna, fresh or frozen	....	50,000	....
Shark fins, dried and unsalted	....	1,488	....
Shrimp and prawns	6,080	....	....
Costa Rica			
Shark fins, dried and unsalted	11,193	3,080	....

CUBA			
Tuna, fresh or frozen	....	12,052	182,040
Halibut salmon, and fresh-water fish	....	....	46,554
Fish filleted etc., nes, fresh or frozen	6,720	9,360	136,293
Frog legs, fresh chilled frozen	602,483	734,532	360,744
Shark fins, dried and unsalted	13,015	2,199	1,791
Fish whole, etc., nes, fresh or frozen	52,905	6,367	136,133
Tuna fish in oil	....	....	8,823
Bonito and yellowtail-over 9 cents	....	50	840
Fish pickled nes-over 15 pounds	7,500	....	....
Lobster, not canned	1,150,792	1,449,217	1,082,914
Lobster, canned	294,449	166,248	719,388
Turtles	....	17,288	17,225
Crabs, prep. or pres. nes	....	2,690	1,406
Crabs, fresh or frozen	1,287	9,140	49,439
Shrimp and prawns	14,496	....	....
Shellfish, nes	2,500	50	....
FRENCH GUIANA			
Shark fins, dried and unsalted	499	905	....
GUATEMALA			
Lobster, canned	1,238	....	....
Shrimp and prawns	....	2,000	....
HONDURAS			
Halibut salmon and fresh-water fish	....	....	6,572
Shark fins, dried and unsalted	221	241	497
Fish whole, etc., nes, fresh or frozen	....	7,864	2,000
Lobster, not canned	6,616	15,200	2,680
Turtles	....	....	800
JAMAICA			
Fish filleted, etc., nes, fresh or frozen	....	....	101
Shark fins, dried and unsalted	25	620	461
Fish whole, etc., nes, fresh or frozen	....	....	932
Lobster, not canned	7,150	11,250	27,160
Turtles	278,845	355,970	489,053
Shellfish, nes	....	....	960
LEEWARD ISLANDS			
Shark fins, dried and unsalted	....	....	36
Fish whole, etc., nes, fresh or frozen	....	5,526	1,041
Lobster, not canned	2,085	52,590	35,608
Turtles	32,100	20,257	68,150
Shellfish, nes	....	....	100
MEXICO			
Tuna, fresh or frozen	1,984,146	1,990,098	49,691
Halibut salmon, and fresh-water fish	12,546	8,373	61,148
Fish filleted, etc., nes, fresh or frozen	3,927	12,455	90,117
Shark fins, dried and unsalted	177,248	157,512	40,093
Fish, nes, dried and unsalted	5,735	1,369	....
Fish whole, etc., nes, fresh or frozen	3,432,853	3,867,872	3,808,183
Tuna fish in oil	....	44	44
Tuna Antipasto and smoked pollock	....	....	60
Antipasto in oil, not over 9 cents	....	18	....
Antipasto in oil, over 9 cents	17	217	....
Fish roe, not boiled	65	939	2,74
Clams, excl. razor and clam comb.	....	9,450	13,26
Fish pickled, nes, over 15 pounds	17,196	16,937	8,93
Lobster, not canned	2,052,531	2,053,779	2,223,24
Lobster, canned	....	3,300	....

Turtles	444,479	627,479	585,513
Crabs, fresh or frozen	4,409	....	....
Clams, fresh or frozen, not airtite	307,368	255,448	827,567
Shrimp and prawns	21,477,390	29,382,193	39,652,640
Scallops, frozen, dried, canned	....	....	2,071
Oyster, fresh or frozen, not airtite	4,728	5,426	34,050
Abalone	4,428,085	5,036,772	4,559,799
Shellfish, nes	21,764	1,874	21,854
NETHERLAND'S ANTILLES			
Shark fins, dried and unsalted	....	2,840	1,000
Lobster, not canned	....	....	1,750
NICARAGUA			
Shark fins, dried and unsalted	19,363	8,773	....
Lobster, not canned	406	....	....
Turtles	27,300	21,150	104,800
Shrimp and prawns	....	1,900	....
Oyster, fresh or frozen, not airtite	248	....	....
PANAMA			
Shrimp and prawns	....	....	143,006
TRINIDAD			
Shark fins, dried and unsalted	....	7,368	....
Lobster, not canned	....	50	....
VENEZUELA			
Shark fins, dried and unsalted	....	17,726	....
Fish pickled, nes, over 15 pounds	8,470	12,936	....

PRODUCTION, NUMBER OF FISHING CRAFT AND NUMBER OF FISHERMEN[1] IN THE GULF AND CARIBBEAN AREA

	Pounds Landed	Number of Fishing Craft	Number of Fishermen
DEPENDENT COUNTRIES:			
Honduras	600,000	100	200[2]
Venezuela	122,800,000	4,260	20,000
Costa Rica	4,400,000	100	200[2]
Colombia	10,000,000	1,238	2,116
Nicaragua	200,000	100[2]	200[2]
Panama	1,400,000	224	530
Mexico	105,000,000	4,056	11,000
Guatemala	200,000	100	200
El Salvador	800,000	100[2]	250[2]
Dominican Republic	1,000,000	587	1,383
Haiti	3,000,000	2,000[2]	4,000
Cuba	42,200,000	2,509	40,000
	291,600,000	15,374	80,079
DEPENDENCIES:			
Bahamas	1,600,000	133	624
Barbados	500,000	800[2]	2,000[2]
British Guiana	4,000,000	383	700
British Honduras	600,000	500	500
Curacao	1,000,000	200[2]	400[2]
French Guiana	6,000,000	30[2]	30

[1] Latest figures available for the respective country.
[2] Interpolated estimates

Guadeloupe	800,000	854	3,372
Jamaica	11,000,000	3,000[2]	7,500
Leeward Islands	1,400,000	837	1,600
Montserrat	600,000	800[2]	2,000
Anguilla-St. Kitts Nevis	1,800,000	800[2]	1,600
Virgin Islands (U.K.)	400,000	200[2]	400
Martinique		654	805
Puerto Rico	2,600,000	1,900	1,369
Surinam	2,000,000	500[2]	833
Trinidad and Tobago	2,000,000[2]	948	2,000
Virgin Islands (U.S.A.)	11,200,000	286	405
Windward Islands	3,000,000[2]	2,216	4,000
Dominica	2,200,000	300[2]	600
Grenada	2,400,000	300[2]	600
St. Lucia	3,200,000	400[2]	800
St. Vincent	3,400,000	400[2]	800
	61,700,000	16,441	32,93
States of the United States:			
Texas	21,993,000	895	1,63
Louisiana	163,900,000	4,095	6,25
Mississippi	70,786,000	934	1,66
Florida	243,845,000	6,740	11,00
	500,524,000	12,664	20,55
TOTAL FOR AREA	853,824,000	44,479	133,57

MONDAY—NOVEMBER 12

Chairman—RICHARD A. KAHN, Chief, Branch of Economic Facilities, Defence Fisheries Administration, Washington, D. C.

Some Economic Aspects of the Southern Shrimp Fishery

WALTER H. STOLTING, *Chief, Economic and Cooperative Marketing Section, Fish Wildlife Service, Washington, D. C.*

THE TITLE OF THIS PAPER appropriately describes the material which has been gathered in its preparation and is about to be presented. This paper covers only some of the economic aspects of the southern shrimp fishery. It sketches in the form of tables and graphs the broad economic boundaries of the concepts of production, distribution and consumption of shrimp in the United States.

Shrimp has rapidly become an item of increasingly great wealth in the fishery industry of the United States, especially during and since World War II. The value of the production of shrimp at the ex-vessel level has increased from an estimated value of $3,172,000 in 1935 to an estimated value of $36,000,000 in 1950. This information is shown in Table 1, along with data for other specified years during that period. The average price at the ex-vessel level is given in Table 2. which shows a rise from an estimate of 2.56 cents per pound in 1935 to an estimated 18.46 cents per pound in 1950. This again is a rather large increase, amounting to 721 per cent.

TABLE 1

EX-VESSEL VALUE OF SHRIMP PRODUCED IN THE UNITED STATES[1] FOR SPECIFIED YEARS 1935-1950

Year	Dollars	Year	Dollars
1935[2]	3,172,000	1940	5,954,000
1936	3,873,000	1945	21,369,000
1937	5,087,000	1949[2]	33,489,000
1938	4,653,000	1950[2]	36,000,000
1939	4,913,000		

Source: Fish and Wildlife Service.

[1] Includes small amount produced in Alaska
[2] Estimated

TABLE 2

AVERAGE EX-VESSEL PRICE OF SHRIMP PRODUCED IN THE UNITED STATES FOR SPECIFIED YEARS 1935-1950

Year	Cents per lb.	Year	Cents per lb.
1935[2]	2.56	1940	3.90
1936	3.19	1945	11.17
1937	3.55	1949[2]	19.31
1938	3.25	1950[2]	18.46
1939	3.27		

Source: Fish and Wildlife Service.

[1] Includes some Alaskan production
[2] Estimated

In studying these data, it should be mentioned that the increase is not due entirely to stronger demand, or attributed to market increases for the identical product. Aside from these influences, which are represented by general inflationary tendencies and other factors which will be discussed later, some o

TABLE 3

AVERAGE WHOLESALE PRICE OF WHITE JUMBO[1] SHRIMP AT CHICAGO, ILLINOIS, BY MONTHS

Sept. 1938 - Dec. 1950

	1938	1939	1940	1941	194
		(Cents per pound)			
Jan.	...	12.3	13.5	16.0	21.5
Feb.	...	15.0	14.0	16.0	26.0
Mar.	...	13.5	18.0	18.0	25.5
Apr.	...	12.5	16.5	21.0	23.0
May	...	12.0	13.0	19.5	24.5
June	...	11.8	14.0	21.5	25.0
July	...	12.0	15.5	25.0	26.0
Aug.	...	13.5	18.5	26.5	30.5
Sept.	14.5	13.0	16.0	25.5	30.5
Oct.	11.0	12.5	14.3	22.0	26.5
Nov.	11.5	11.0	13.3	20.5	27.5
Dec.	10.5	11.0	14.0	20.5	29.0
	1943	1944	1945	1946	194
		(Cents per pound)			
Jan.	31.5	38.2	n.a.	n.a.	63.5
Feb.	33.0	38.2	n.a.	n.a.	69.5
Mar.	30.0	39.2	n.a.	n.a.	n.a
Apr.	45.5	n.a.	n.a.	n.a.	n.a
May	40.0	38.3	n.a.	n.a.	n.a
June	37.0	38.5	n.a.	n.a.	n.a
July	42.5	37.9	n.a.	n.a.	n.a
Aug.	47.5	37.3	n.a.	n.a.	n.a
Sept.	51.0	n.a.	n.a.	n.a.	n.a
Oct.	38.0	n.a.	n.a.	n.a.	n.a
Nov.	38.0	n.a.	n.a.	62.5	n.a
Dec.	37.8	n.a.	n.a.	61.5	n.a
	1948	1949	1950		
		(Cents per pound)			
Jan.	69.0	71.5	73.5		
Feb.	72.5	74.0	74.0		
Mar.	72.5	74.0	74.0		
Apr.	72.5	74.0	75.5		
May	70.0	74.0	77.0		
June	70.0	75.0	77.0		
July	75.0	76.0	76.5		
Aug.	81.0	76.0	74.5		
Sept.	80.5	74.5	72.5		
Oct.	74.5	71.5	67.5		
Nov.	72.0	70.5	60.5		
Dec.	69.0	71.0	60.5		

Source: Fish and Wildlife Service.

n.a.—not available

[1] In earlier years of this table known as 25-and-under count (headless) and later y 15-20 count (headless). From Jan. 1948 on product is frozen.

ne rise probably has been due to a tendency for the fleet to catch an increasing roportion of the larger sizes of shrimp which sell for higher prices. This tuation alone would tend to raise the value and price in recent years.

In order to avoid the influence of changing sizes, and to present a series

TABLE 4

AVERAGE WHOLESALE PRICE OF WHITE MEDIUM[1] SHRIMP AT CHICAGO, ILLINOIS, BY MONTHS

Sept. 1938 - Dec. 1950

	1938	1939	1940	1941	1942
		(Cents per pound)			
ın.	...	n.a.	9.5	13.0	n.a.
eb.	...	n.a.	11.5	15.8	n.a.
ſar.	...	n.a.	15.5	19.5	n.a.
pr.	...	10.0	15.5	17.0	22.5
ſay	...	n.a.	n.a.	17.5	n.a.
ıne	...	n.a.	n.a.	n.a.	n.a.
ıly	...	n.a.	n.a.	n.a.	n.a.
ug.	...	12.0	n.a.	n.a.	n.a.
ct.	10.5	11.0	11.5	20.0	23.5
ov.	10.0	n.a.	n.a.	n.a.	n.a.
ec.	n.a.	n.a.	11.8	n.a.	n.a.
pt.	11.5	11.0	14.5	21.0	26.5
	1943	1944	1945	1946	1947
		(Cents per pound)			
n.	31.0	32.0	n.a.	n.a.	60.5
b.	29.5	32.0	n.a.	n.a.	60.0
ar.	n.a.	33.2	n.a.	n.a.	n.a.
or.	45.5	n.a.	n.a.	n.a.	n.a.
ay	34.5	32.9	n.a.	n.a.	n.a.
ne	35.0	30.0	n.a.	n.a.	n.a.
ly	n.a.	n.a.	n.a.	n.a.	n.a.
ıg.	36.0	31.0	n.a.	n.a.	n.a.
pt.	21.5	n.a.	n.a.	n.a.	n.a.
t.	31.8	n.a.	n.a.	n.a.	n.a.
ov.	31.0	n.a.	n.a.	54.0	n.a.
c.	31.0	n.a.	n.a.	54.0	n.a.
	1948	1949	1950		
	(Cents per pound)				
n.	...	61.5	63.0		
b.	64.0	64.0	63.0		
ır.	64.0	64.0	63.0		
r.	64.0	64.0	65.5		
ıy	60.0	64.0	68.0		
ıe	59.5	65.0	68.0		
y	64.0	66.0	66.0		
g.	67.0	66.0	62.5		
t.	64.0	65.0	61.0		
.	60.0	61.5	58.5		
v.	59.5	58.0	52.5		
c.	59.0	60.0	52.0		

Source: Fish and Wildlife Service.

—not available

reliminary 26-30 count (headless). From Jan. 1948 on product is frozen.

of data showing prices for approximately the same product throughout time, a series of wholesale prices for shrimp at Chicago, for the period September 1938 to December 1950, has been developed. This is shown in Tables 3 and 4. The former table presents data for white jumbo shrimp, and the latter table for white medium shrimp. The prices in each table cover practically the same size of shrimp all the way through. In earlier years, the product was predominantly fresh shrimp, and in later years predominantly frozen shrimp. There may be some tendency for a rise in prices in recent years attributable to the fact that frozen shrimp usually sells at a slight premium over fresh shrimp. However this would not be a significant factor in comparing earlier and later years in the table since the premium for frozen shrimp rarely amounts to more than a few cents per pound, and the changes in prices between the earlier and later years in the table are, as depicted, of larger magnitude. The rather large rise in prices is repeated in these tables, white jumbo shrimp increasng from a value of 10.5 cents per pound in December 1938 to 60.5 cents per pound in December 1950, a 576 percent increase. White medium shrimp increased from a value of 10 cents per pound in November of 1938 to 52.5 cents per pound in November 1950, an increase of 525 percent. In preceding months each of these sizes of white shrimp had been selling at even higher levels.

In addition to the aforementioned price data, some further interesting information is shown in Table 5, which depicts the average wholesale price of brown grooved shrimp at Chicago, by months, during recent years. This information is shown primarily to note the discount in prices paid for brown grooved shrimp as compared to white shrimp on the same market.

TABLE 5

AVERAGE WHOLESALE PRICE OF GROOVED (BROWN) SHRIMP AT CHICAGO, ILLINOIS, BY MONTHS

Jan. 1949 - Dec. 1950

	1949	1950		1949	1950
	15-20 Count (headless)			26-30 Count (headless)	
	Cents per lb.			Cents per lb.	
Jan.	...	67.0	Jan.	...	59.0
Feb.	...	67.0	Feb.	...	57.0
Mar.	...	68.5	Mar.	...	60.0
Apr.	69.0	71.5	April	55.0	61.0
May	69.0	74.0	May	55.0	63.0
June	69.0	74.0	June	55.5	63.0
July	69.0	74.0	July	55.5	64.0
Aug.	69.0	69.5	Aug.	55.5	58.5
Sep.	65.0	65.0	Sep.	57.0	56.0
Oct.	63.0	62.0	Oct.	54.0	51.5
Nov.	63.0	55.5	Nov.	54.0	46.0
Dec.	65.0	57.5	Dec.	52.5	49.0

Source: Fish and Wildlife Service.

That the rise in prices has been rather large, can be readily indicated when the increases in the aforementioned value and price series are compared with other available general data. In Table 6 are shown the Bureau of Labor Statistics wholesale price series for all commodities and for foods for the same period. It will be noted that the increase in the series of index numbers for prices of all commodities amounts to only 205 percent. For the food group the increase

mounts to only 226 percent. Both of these series show very much less of an ncrease than do shrimp prices.

The situation depicted in these tables and in Figure 1 indicates that the rise n shrimp prices is not solely due to inflationary tendencies. If the 225 percent ncrease in wholesale food prices (which brings the value of the dollar to about 5 cents when compared to the 1935 dollar) is used as an indication of an verage increase due to inflation, there is something still more to explain about

FIG. 1

PRICE OF SHRIMP, WHOLESALE PRICE LEVEL AND FRESH AND FROZEN SHRIMP SUPPLY

1938 — 1950

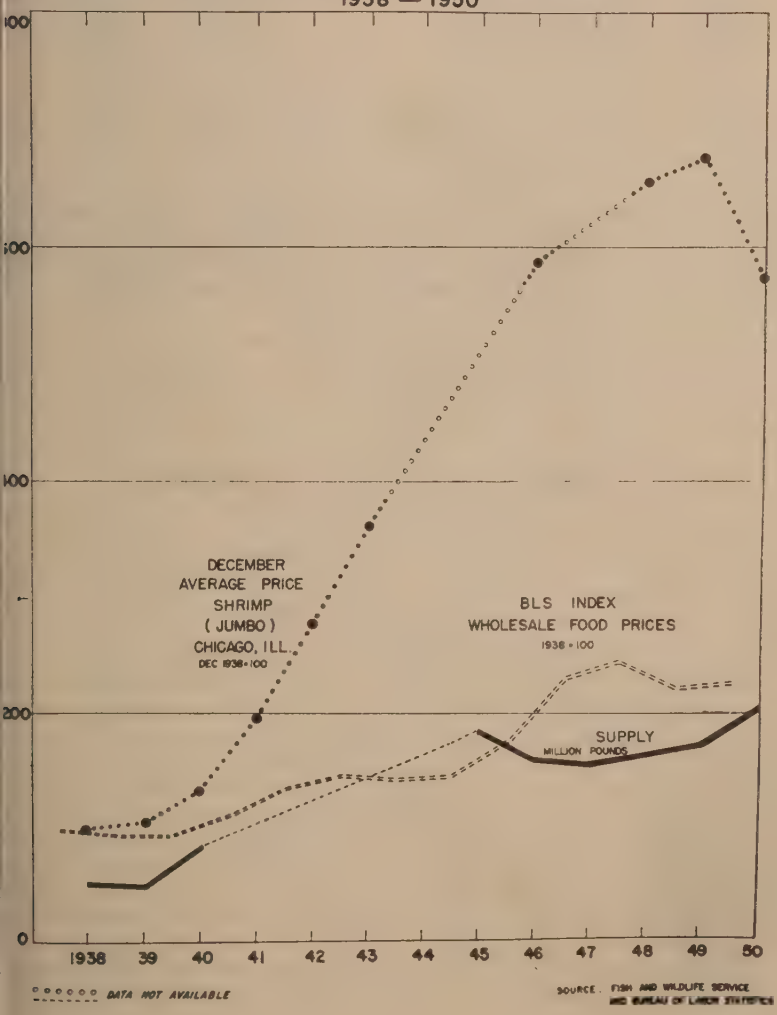


TABLE 6

BUREAU OF LABOR STATISTICS INDEX NUMBERS OF WHOLESALE PRICES FOR ALL COMMODITIES AND FOR FOODS, 1938-1950

(Base - 1926 = 100)

Year	All Commodities	Foods
1938	78.6	73.6
1939	77.1	70.4
1940	78.6	71.3
1941	87.3	82.7
1942	98.8	99.6
1943	103.1	106.6
1944	104.0	104.9
1945	105.8	106.2
1946	121.1	130.7
1947	152.1	168.7
1948	165.0	179.1
1949	155.0	161.4
1950:		
Jan.	151.4	154.8
Feb.	152.8	156.7
Mar.	152.7	155.5
Apr.	152.8	155.3
May	155.9	159.9
June	157.3	162.1
July	162.9	171.4
Aug.	166.4	174.6
Sep.	169.5	177.2
Oct.	169.1	172.5
Nov.	171.7	175.2
Dec.	175.3	179.0
Year	161.5	166.2

Source: Bureau of Labor Statistics.

shrimp price increases. If this inflationary effect is taken out of the shrimp price by a process of dividing each shrimp price by the index number for wholesal food prices, there is still a sizeable increase left to explain. A lessening of shrimp supplies cannot be looked to for the whole answer. As shown in Figure 1, sup plies of fresh and frozen shrimp have increased in most years during this period

Ordinarily, when supplies go up, prices go down, and conversely, but here, i the case of fresh and frozen shrimp, in most years a condition of rising price prevails in spite of an increase in supplies. This is particularly true of the year 1940 through 1949. Explanations of this condition are not directly available However, some deductions may be offered. From the data it is apparent that relatively greater proportion of consumers' money has become available for us for the purchase of fresh and frozen shrimp, as compared to other foods. Th total number of dollars used for such purchases has been relatively greate When divided by the total pounds of shrimp available, these have resulted i a higher price plane. One situation about which definite information is know which should result in this condition, is that more consumers have become ac quainted with fresh and frozen shrimp and are purchasers of that product. Th advent of new freezing techniques and increased consumer incomes has prob ably helped to bring shrimp to places where it formerly was not used.

Several years ago the Fish and Wildlife Service made a survey which clearl indicated that fresh and frozen shrimp were receiving wider distribution. Thi particular group represents the form in which the predominate part of the tot supply supply is marketed. The survey made for the year 1946 duplicated a earlier survey made in 1936 in which sixty odd cities were included, to dete mine the species of fish and shellfish of principal importance in the retail trad of those cities of the United States. The information was published in Fisher Leaflet 365, entitled, *Sales Patterns for Fresh and Frozen Fish and Shellfis* 1936 & 1946, and it definitely showed that shrimp were getting wider distribu tion in the cities surveyed. The following quote from this publication wi illustrate this:

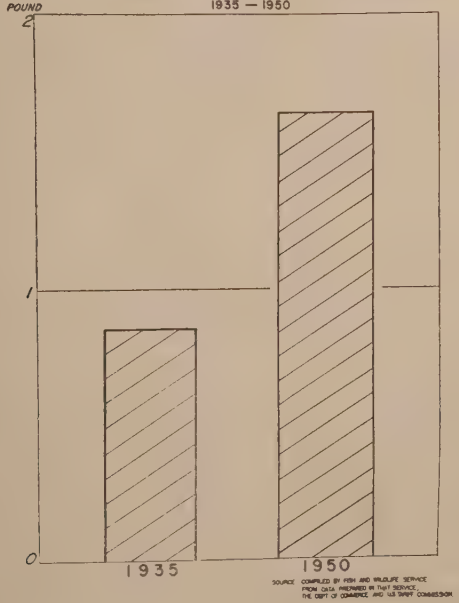
"Shrimp, particularly, was reported many more times in 1946 than in 1936. It also displaced local or regional varieties formerly most favored

during many months of the year in Milwaukee, Wisconsin, and Tucson, Arizona. The cities in which shrimp was marketed [in volume]* in 1946 but not in 1936 are the following:

"Albuquerque, N. Mex.
Atlanta, Ga.
Boston, Mass.
Cincinnati, O.
Cleveland, O.
Davenport, Ia.
El Paso, Tex.
Indianapolis, Ind.
Lincoln, Neb.
Los Angeles, Calif.
Manchester, N. H.
Milwaukee, Wis.
Minneapolis, Minn.
New Haven, Conn.
Norfolk, Va.
Peoria, Ill.
Pittsburg, Pa.
Richmond, Va.
St. Paul, Minn.
Salt Lake City, Ut.
Scranton, Pa.
Seattle, Wash.
Wichita, Kans."

Since data in the aforementioned publication nullify the possibility that the ame number of original consumers were eating the increased amounts of shrimp eing marketed, this information would indicate that more people have become cquainted with fresh and frozen shrimp, resulting in an increase in the per cap- ta consumption of that product. Such an increase, in turn, would be reflected in n increase in the per capita consumption of all shrimp, all other factors re- naining constant. Per capita consumption of all shrimp has increased, as is hown in Tables 7 and 8. The apparent consumption of shrimp in terms of fresh

FIG. 2
SHRIMP — APPARENT PER-CAPITA CONSUMPTION OF ALL FORMS COMBINED (IN TERMS OF FRESH, WHOLE SHRIMP)
1935 — 1950



SOURCE COMPILED BY FISH AND WILDLIFE SERVICE FROM DATA PREPARED BY THAT SERVICE, THE DEPT OF COMMERCE, AND U.S. TARIFF COMMISSION

Words in brackets added.

TABLE 7

SHRIMP—UNITED STATES PRODUCTION, EXPORTS, IMPORTS AND APPARENT CONSUMPTION (IN TERMS OF FRESH, WHOLE SHRIMP)

FOR SPECIFIED YEARS 1935-1950

Year	Production[1] 1,000 lb.	Domestic Exports 1,000 lb.	Imports for Consumption 1,000 lb.	Apparent Consumptio 1,000 lb.
1935	[2]123,824	[3]19,613	4,549	108,760
1937	143,448	34,044	5,674	115,078
1938	143,101	34,128	6,877	115,850
1939	150,250	35,608	7,560	122,202
1945	191,345	7,519	13,240	197,066
1946	[2]175,000	5,112	21,130	191,018
1947	[2]170,000	10,313	22,477	182,164
1948	[2]165,000	6,381	36,579	195,198
1949[4]	[2]170,556	13,412	51,077	208,221
1950	[2]186,472	8,642	69,853	247,683

Source: Production, statistics of the Fish and Wildlife service; exports an imports compiled by U. S. Tariff Commission from official statistic of the Department of Commerce; apparent consumption, compiled b Fish and Wildlife Service.

[1]Includes a small amount produced in Alaska
[2]Estimated
[3]Does not include canned shrimp
[4]Preliminary

TABLE 8

SHRIMP—APPARENT PER-CAPITA CONSUMPTION OF ALL FORMS COMBINED (IN TERMS OF FRESH, WHOLE SHRIMP)

1935-1950

Year	Pound	Year	Pound
1935	.855	1946	1.365
1937	.893	1947	1.270
1938	.892	1948	1.336
1939	.934	1949	1.402
1945	1.493	1950	1.638

Source: Compiled by Fish and Wildlife Service from data prepared in tha Service, the Department of Commerce and U. S. Farm Commission.

whole shrimp has increased from 108,760,000 pounds in 1935 to 247,683,00 pounds in 1950—more than double. This information converted to a per capit basis shows an increase in per capita consumption from .855 pounds in 1935 t 1.638 pounds in 1950—slightly less than double. Per capita consumption dat are shown in Table 8 and graphically in Figure 2. Data for specified intervenin years are also shown in the tables. It should be re-emphasized that these dat are on a fresh whole shrimp basis and that they would amount roughly to .4 pounds in 1935 and .82 pounds in 1950 on a marketed weight basis.

This increased demand, coupled with successful efforts to market varieties o shrimp other than white shrimp, has been a great incentive to expansion in th

TABLE 9

ANNUAL SHRIMP CATCH IN THE UNITED STATES[1] BY STATES FOR SPECIFIED YEARS (IN TERMS OF FRESH, WHOLE SHRIMP)
1931-1950

Year	North Carolina	South Carolina	Georgia	Florida	Alabama	Mississippi	Louisiana	Texas	Total South Atlantic & Gulf States	Total Other[1] States	Total United[1] States
						1,000 lb.					
1931	338	2,635	5,471	18,853	2,475	17,716	35,148	13,815	96,451	2,981	99,432
1932	292	1,501	3,601	18,136	3,382	14,010	38,096	9,244	88,262	3,442	91,704
1934	2,564	1,801	6,843	16,292	4,557	15,330	55,572	16,359	119,318	2,710	122,028
1936	3,815	1,101	9,715	20,725	1,869	17,493	53,430	9,962	118,110	3,452	121,562
1937	4,184	1,201	9,504	14,037	3,104	23,558	68,781	16,905	141,274	2,174	143,448
1938	4,569	3,723	10,426	10,143	3,643	9,902	81,379	16,365	140,150	2,951	143,101
1939	4,811	4,089	10,802	8,782	2,124	5,676	100,613	11,173	148,070	2,180	150,250
1940	4,156	1,784	9,336	8,369	4,565	8,566	98,986	14,779	150,541	2,122	152,663
1945	10,614	4,696	16,392	13,662	4,439	6,595	116,904	15,722	189,024	2,321	191,345
1949[2]	1,392	11,845	8,776	13,662	2,664	2,842	85,707	33,668	166,556	4,000	170,556
1950[2]	6,637	7,285	6,929	23,216	3,645	(92,257)		42,503	182,472	4,000	186,472

Source: Fish and Wildlife Service

[1] Includes a small amount produced in Alaska
[2] Preliminary Estimate

fishery. With the advent of the construction of larger and more expensive trawlers, which are able to fish on more distant shrimping grounds and the use of more modern instruments and gear, this expansion has occurred. In addition, distant foreign sources of production have been brought into the market. The size of the expansion can be noted in succeeding tables. Table 9 shows the annual shrimp catch in the United States for specified years 1931-1935. This information is given in terms of fresh whole shrimp. It will be noted that the catch of domestic fishermen has increased from 99,432,000 pounds in 1931 to an estimated 186,472,000 pounds in 1950. This is nearly a doubling of production on the part of the domestic industry. The rapid rise in the importance of certain States as producers in recent years is also shown. In addition to this source, the contribution to domestic supplies by foreign producers should not be overlooked. The greatest volume of importations of shrimp from foreign sources, occurs in the fresh or frozen form. United States imports of that product for the years 1935 through 1950 are shown in Table 10. It will be noted that they have also

TABLE 10

UNITED STATES IMPORTS OF FRESH OR FROZEN SHRIMP (in terms of headless weight)

1935-1950

Year	*Total U.S. Shrimp Imports Pounds*	*Shrimp imports from Mexico Pounds*	*Percentage of Mexican Imports to Total U.S. Imports Percent*
1935	1,863,949	1,574,077	84.4
1936	808,902	552,942	68.4
1937	2,400,075	2,058,741	85.8
1938	3,459,558	3,242,809	93.7
1939	3,984,142	3,797,231	95.3
1940	5,024,325	4,912,552	97.8
1941	3,161,832	3,115,933	98.5
1942	4,436,290	4,419,306	99.6
1943	5,749,321	5,746,545	99.95
1944	6,083,679	6,081,509	99.96
1945	7,875,789	7,873,888	99.98
1946	12,243,975	12,056,001	98.5
1947	13,274,965	13,228,505	99.7
1948	21,563,023	21,477,390	99.6
1949	29,673,205	29,382,193	99.0
1950	40,198,063	39,652,640	98.6

Source: Census Bureau

increased greatly from 1,863,949 pounds in 1935 to 40,198,063 pounds in 1950. This is in terms of headless weight. Mexico has been the greatest source of supply, contributing in the most recent full year, 1950, 39,652,640 pounds or roughly 98.6 percent of all imports in this category.

From 1940 to 1949 this expansion has occurred without any hindrance. Even with increased supplies, prices held firm or rose, resulting in a healthy condition for the expansion of the industry. However, it should be noted from Figure 1 that in the most recent years there is a tendency for a return to normal supply price reactions. There was a considerable expansion in the industry in 1950 with a resultant drop in prices. With this situation in mind, and comparing it to conditions before 1940, it appears that the fresh and frozen shrimp market will

more changeable and subject to more direct price reactions when supply anges. and that expansion will not come as easy as during the war and im-ediate postwar years.

In connection with the marketing of frozen shrimp, it is appropriate to men-on that at the present time in the Economics and Cooperative Marketing Sec-on, Branch of Commercial Fisheries of the Fish and Wildlife Service, there being conducted a consumer preference survey for all frozen fishery products. this survey, information will be obtained which may be of particular interest members of the shrimp industry. Some of the items on which information ll be obtained are as follows: preference for size of package; preference for ape of package; preference for information, such as nutritional value, recipes, ight, etc. shown on packages; preferences for prepared fish, such as breaded ms, prepared fish dinners, etc.; availability of frozen fish and shellfish at store ere most of the consumer's shopping is done.

It was previously stated that the material presented would merely sketch broad onomic boundaries of production, distribution and consumption. There is uch more work to be done of a specific nature to throw further light on the onomics of shrimp production and distribution. Some of the more important es of analyses which will receive the consideration of the Economics and operative Marketing Section in the future are as follows: information on r capita consumption of shrimp by various types of processed product; effect consumer incomes on demand for shrimp; effect of supplies on prices of) canned shrimp, (b) frozen shrimp, (c) fresh shrimp, both nationally and various markets; analysis of effect of advertising programs on consumption, .; general survey of present economic status of shrimp industry.

Trade Relations of Norway with the Gulf and Caribbean Area

MAGNE OPPEDAL, *Fisheries Attache, The Norwegian Embassy, Washington, D. C.*

THE SOUTHERNMOST POINT IN NORWAY is located at about the same latitude as southern tip of Greenland, or the middle of the Hudson Bay. The north-most point, Northcape, lies slightly farther to the north than Point Barrow. Notwithstanding her arctic location, Norway has ice-free harbors all along coast, making it possible to maintain a population of some three million o hundred thousand. That it is at all possible to live in Norway is, of urse, due to the influence of the Gulf Stream, whose warm waters cross Atlantic to sweep along the Norwegian coast, resulting in a temperate mate. The Gulf Stream is indeed the Caribbean's gift to Norway.

Although people can make their living in Norway's ice-free ports and in mountainous hinterland, stretching to the borders of Sweden, Finland, d the Soviet Union, the natural conditions of life are meager, indeed, st of the country consisting of barren mountains or covered with vast ests. Only 3 per cent of the total area is cultivated, and opportunity for wing grain, vegetables, and other agricultural products is very limited. maintain its relatively high standard of living, Norway must import ny essential commodities. In 1938, Norway's imports per capita were passed only by New Zealand. Averaging about 225 Norwegian kroner per

individual, the 1938 imports accounted for close to 50 per cent of the mon each family spent for food.

Norway has comparatively few commodities to offer in internation trade, and two of the most important are closely linked to the sea. Fir is Norwegian shipping, which, with its 5.7 million gross tons, ranks thi in the world, carrying goods to and from every port around the glob Secondly comes the Norwegian fisheries.

Every year, in winter, spring, and early summer, enormous schools cod and herring seek the warm coastal waters to spawn or to feed. T annual catch by Norway's 80,000 fishermen runs as high, or higher th one million tons. The enormous quantities of fish can not, of course, consumed by Norway's three million people. Since time immemorial, has been necessary for Norway to export her surplus of fish.

There has been considerable argument in Norway as to whether f exports have developed the Norwegian merchant marine or vice versa. any case there has at all times been a close connection between these t trades. Just when the Norwegian fish exports to the Gulf and Caribbe areas began, is not exactly known, but they go back a great many yea probably following close behind Columbus.

Information available on Norway's trade with the Caribbean and G areas, presents an interesting picture.

In some parts of the area, trade was initiated by Norwegian impo but gradually building up her exports, Norway sought a balanced tra In other parts, the picture is the reverse. Before the war, Norwegian ports to the area were far below her imports. Through 1930-35, Norwa annual imports from the area amounted to little more than 9 million N wegian kroner, in part offset by Norwegian export, totalling slightly m than 6 million kroner. Less than one-third of this consisted of fish produ Figures for 1938, usually accepted as a governing year, show very li difference in the exchange of goods between Norway and the Gulf a Caribbean area. In that year Norwegian imports amounted to 29 mill kroner, while Norway's exports to the area totalled only 6.5 million kro of which close to 2.5 million or one-third consisted of fish products.

To get a true picture of Norway's trade with the area, we must also consi the role of the Norwegian merchant marine. Of all Norwegian ships call at foreign ports, nearly one sixth were in the Gulf and Caribbean ar Ports, such as Curacao, Aruba and Port of Spain, were visited by ab one Norwegian vessel every day of the year, and other ports, such as P Royal, Santiago de Cuba, and Havana, saw at least one Norwegian ve every second day. Today Norwegian shipping companies maintain five li linking the area directly with Norway and the other Scandinavian countr In that way Norway pays for its imports with transport services.

Since the war Norway's trade with the Caribbean and Gulf areas changed to some extent, owing largely to the abnormal and artific created foreign exchange situation. Due to the losses suffered during war and the German occupation, Norway has been obliged to curtail ports of non-essential commodities, just to rebuild the country. Norwa obviously eager to expand its foreign trade, which it must do to attain pre-war standard of living.

It is felt, that in a not too distant future, the Gulf and Caribbean will become a major source of Norwegian supplies, and it is since

oped that, in the years to come, ways will be devised to increase the exange of goods.

According to Fishery Leaflet 259, issued by the United States Fish and ildlife Service, the production of fish in the Caribbean is about equal the importation of fish products. The fish consumption in the various aribbean countries shows an amazing variation, ranging from only one half ound per capita to as much as 180 pounds, the average being 20.2 pounds. he highest fish consumption is found in countries where most of the catch consumed by the fishermen themselves, and very little is sold through ommercial channels. This situation would suggest that others of the Caribean countries could develop their fish consumption through up-to-date arketing methods. Additional demand for fish may result from the recent ithdrawal of the Bull of the Crucades, decreed about five hundred years go. Real progress, however, can come only as a result of concerted efforts the trade itself. By so doing, the trade will also help to promote a higher andard of living in the respective countries.

Recent reports from the United Nations' Food and Agriculture Organization dicate that the sub-standard food consumption prevailing in many countries day is due to inadequate supplies. The first task of every country, should to develop its own resources, a field in which international cooperation can of material assistance. Equally important, however, is the promotion of free flow of goods between the different parts of the world. In this conction the urgency of avoiding the creation of artificial trade barriers to pport a small and comparatively insignificant domestic production is phasized.

It has been a pleasure for Norway to take part in the constantly closer ernational cooperation, designed to promote throughout the world the hnical aspects of fisheries and conservation of known resources. Norway oks forward to an application of the same spirit of international cooperation regard to the distribution of fish and fish products in all world markets, on e basis of free and unfettered competition.

The Interest of the Office of Price Stabilization In Southern Species of Fish

WILLIAM C. EARDLEY, *Head, Fish Section, Office of Price Stabilization, Washington, D. C.*

E ONLY INTEREST OF THE OPS in southern species of fish, is to stabilize ces. To quote Mr. Edward Phelps, Director of the OPS' Office of Price erations, the immediate program of OPS is "to build quickly a more bilized price structure to guard the nation against the heavier inflationary ssures anticipated in the winter and spring."

Those dealers, who are in the fresh and frozen fish trade, know that fresh d frozen fish and shell-fish are exempt from price control. At the present time ners of fish or shell-fish know that most canned fish items are controlled der CPR 22, except canned salmon and canned Maine sardines. These last items mentioned are now under individual regulations setting dollars-and-ts ceilings.

Probably the question in the minds of the industry is what it has to look

forward to in the matter of price controls and its relationships with OPS What would apply to the Southeastern states would also apply to the entir country. This question can best be answered by quoting again a recent OP press release, dated October 22nd. Mr. Michael DiSalle sent a memorandu to the Office of Price Operations and declared "Our objective must be to kee from increasing prices and to reduce them wherever possible. Any increas should be the exception rather than the rule and I will not sign any regulatio increasing prices past GCPR levels unless accompanied by the fullest kin of economic justification." This memorandum answers the canners' questio to a great extent.

As to fresh and frozen shell-fish, the Fish Section of OPS has kept runnir weekly charts of country-wide price fluctuations of the most importa species of fish. With the few exceptions, and considering seasonal variation prices are below those prevailing during the GCPR freeze period, Decemb 19, 1950 to January 25, 1951.

If these prices are exceeded, there is every indication that ceilings will l imposed in the case of fresh fish and re-imposed in the case of frozen fish. Th might be a rather strong unofficial statement, but in a general way this is b lieved to represent the present thinking of OPS.

What Are the Major Problems of the Fisheries?

HARDEN F. TAYLOR, *Institute of Fisheries Research, Beaufort, N. C.*

PROBLEMS DO NOT EXIST IN NATURE apart from ourselves; they are mere states of our minds about things we desire or think we ought to do. Th motivate and determine what we do. The effectiveness of our efforts in search in the fisheries therefore depends on what we consider the proble to be, or our choice from all the things that we might be doing of those whi will yield the greatest values.

The chief problem of the fisheries expressed in the broadest terms, What can science do to enlarge the contribution of the fisheries to hum wealth and welfare?

It must be admitted that science has done very little to make the fisher more productive in comparison with what it has done for agriculture. Ag culture has always been regarded as a source of wealth to be promoted efficiency and productivity by every possible means, while the fisheries h been considered to be in danger of exhaustion and not to be promoted efficiency but to be protected, conserved, restricted and hampered. The c sequences, at least in part, of these two opposite public attitudes are ea seen in the comparative performances of fisheries and agriculture. The gr increase in the human population of the earth in the past two centuries been made possible by the enormously increased productivity of agricult resulting from improvements in fertilization and irrigation of the soil; sci tific selection, transplantation, acclimation and genetic improvement of pl and animals; control of pests and diseases; grafting and budding of trees; ani nutrition; incubation of eggs; battery production of poultry; mechanization work; storage and refrigeration of produce, statistical services, etc. In United States in 160 years the portion of the population necessarily dev to agriculture to provide the food, fibers, etc., has dropped from 96 to 23

ent and improvements continue by leaps and bounds. While the fisheries ave improved slightly, they have no such record.

The human population of the whole earth appears to derive about one day's ood supply (as calories of food energy) each year from the sea, and 364 ays' from the land. The sea covers 71 per cent of the earth, the land 29 per ent, or about 63 acres of sea per capita of human population, with a pro- uction of less than one-half pound of fish per acre of sea, while the total nd area of the earth is about 17 acres per capita of population, and yields bout 100 pounds of food per acre, plus all the other non-food products of griculture and forestry.

In the United States we have almost the same number of acres of farm nd actually under cultivation as of fishery bottoms of lakes, rivers and off- hore continental shelf; we derive a little less than one per cent of our food om the sea, and 99 plus per cent from the land, plus the non-food lumber, bers, oils, etc. Agriculture is easily capable of further great increase in yield. has been recently estimated that fertilization of grassland in this country, as commended by the agricultural colleges, would make possible a further nnual increase of 2.9 million tons of beef, the increase alone being 29 per nt greater than the present entire production of fish in the United States and laska; and similar improvements can be made by further fertilization of ltivated crops. The total round weight of all fishery products, edible and n-edible, in the United States is about the same as that of eggs, only about x times as much as the cheese, and its value is only four or five times that honey.

These summary facts and figures indicate that we take practically nothing om the water, and so far as national nutrition and employment of labor are ncerned, the fisheries would not be seriously missed if they disappeared al- gether. No species of fish has ever become extinct, so far as we know, and no gional fishery exhausted, and there appears to be no possibility of exhausting y species of fishery for profit. There are vast areas of ocean, many con- ining known rich fisheries not now exploited, and the total world out-take om the sea is of infinitesimal proportions.

Fishing, however intense, in no way affects the supply of fertility in the ter, nor does it affect the production of basic vegetation on which fishes bsist and which appears to be considerably greater at sea per square mile and stly greater in total amount than it is on land.

Although particular species have fluctuated in abundance, in the North rolina Survey there was found no evidence that there has ever been an er-all shortage of fish in the United States, nor are there any bumper crop lean years in the fisheries generally comparable to those caused in agri- lture by droughts, floods, etc. The production of fish in the whole United ates has kept pace, since 1887, with the growth in human population; it s more than kept pace since 1920; the production of the old fisheries of e Atlantic-Gulf regions has grown with the Eastern States' population despite e precipitate decline in the oyster; the production of fish has been accom- shed by fewer fishermen, and the product of the fishereies has been sold lower prices in terms of all other commodities or all other foods. All of se are signs, not of scarcity, but of sufficiency.

Nevertheless, from the earliest times the main problem of the fisheries has en considered to be, how to maintain or increase the supply of fish or to event depletion. That is, abundance of fish was thought to be the main deter- nant of production.

In pursuit of this fear-of-scarcity motive the U. S. Fish Commission fro its beginning in 1871 relied on hatching, transplanting and acclimation o species, and restrictive legislation. Hatching, which reached its peak in abou 1915 with over 100 hatcheries, has been discredited for sea fisheries, an acclimation was discontinued by about 1895. Restrictive legislation, howeve continues as an article of faith to impose inefficiency and disadvantage and di courage creative enterprise of fishermen in competition with agriculture.

The latest and currently popular doctrine which conceives scarcity as th main fisheries problem is that which proposes to maintain optimum or max mum yield of the fisheries by control based on statistical data relating to birt and death rates, recruitment, etc. It holds that public officials can operate th extremely complex and delicate ecological-economic mechanism to bette advantage than it operates itself automatically, and implies the fallacious belie that, if each species is at a maximum, the fishermen will catch and can sell th maxima profitably. When critically examined in all its many other ramification and implications, economic, jurisdictional, and bureaucratic, it seems certai that it will be found to have serious if not fatal defects.

Since we cannot here offer a catalog of problems, let us now take th oyster as one major problem which will illustrate the principles that ought t govern the choice of subjects in the fisheries.

In 1879 it was officially declared that the oyster was more valuable than a the rest of the fisheries. By 1890 (when comprehensive statistics had becom available) the *net edible* weight of oyster meats was more than fifty per ce greater than the *gross round* weight of the nearest rival, the Atlantic ar Pacific codfish, and was 16 per cent of all fish production. Oysters were th highest priced fishery product and the value was 35 per cent of all fish produc in the country. By 1940 the production of oysters was less than half what had been in 1890, a decrease from 16 per cent to 3 per cent of all fish pr duction, while the human population had doubled. The per capita productio of oysters had therefore declined to one-fourth of what it had been in 189

Why did the oyster fishery decline? It was taken for granted that the cau was biological, that oyster rocks were fished out; innumerable researches a activities have since been conducted with a view to restoring abundanc efforts to induce more abundant set, planting of seed, planting of shells a other cultch, enactment of restrictive legislation, cull laws and minimum si limits, closed seasons, restricted sizes of dredges, prohibition in some states power boats for dredging, attempts to control starfish and other enemi limitations on export from states, and many other, with excise taxes impos to meet the expense; not only this, but taxpayers' money has been used to pla shells and otherwise to pay the oyster industry in part what the consum were unwilling to pay for the production of oysters. It did not seem to occ to anybody to consider economic influences, to ask what had happened prices, profits, incentives to produce. It was tacitly or expressly assumed th business people have no foresight, must be restrained by law from wanto destroying the source of their own business, and that profitable opportuni will be allowed to go by default.

A quite different conclusion is indicated when economic factors are cluded in the reckoning. While the quantity of production was being hal in total and quartered per capita from 1890 to 1940, the price failed respond to scarcity. If we compare production in the early period 1887-19 with the late period 1921-1940, it is seen that the annual average quan

ecreased 44½ per cent. The actual price increased only 41 per cent and the tal number of dollars received by oystermen decreased by 22 per cent. But e value of the dollar had also decreased by 29 per cent; so that in terms wholesale prices of all commodities, oysters decreased in price 14.9 per nt, and in terms of all other foods oysters decreased in price by 22½ per nt.

The economic effect of all this is that the net proceeds of sale of all the sters produced annually on the average in the 20-year period 1921-1940, e oystermen could buy only 48 per cent as much of the average of all other mmodities, or 46 per cent as much of the average of all other foods as they uld during the period 1890 to 1908.

Now it is an article of economic faith that the pursuit of gain energizes siness, that where the prospects of profit exist, business will find a way produce, and if the prospects are dim or absent, the business will decline or e. It is also an article of faith that when the public demands something which the supply diminishes, the price rises to the maximum point at hich the total supply can be sold. This is the law of supply and demand. It also a truism that as many men will engage in the business (oystering, here) can make as good a living at *it* as they can at other opportunities open them. The conclusion is inescapable here in falling production, falling real or rchasing power prices, declining total value, and diminishing numbers of ster fishermen, that something happened to demand. For there is as much ttom land under water suitable for oyster growth now as there was in 1890, d there is much more bottom available elsewhere if needed; there is twice as g a human population of potential consumers as there was then and of much eater average income, and the art of cultivating oysters has been known all ng, and is free for all to practice. If the demand were there, prices would e, rising prices would make profits, profits would evoke production by private ltivation if natural beds were adequate.

Meanwhile, apparently more scientific papers have appeared about the oyster an about any other marine animal; but they have had little or no discernible ect. Many of them increased our general scientific knowledge, but were ected to no particular practical problem, while many of the purposeful pers were designed to solve the wrong problems.

We do not yet know exactly what the right problems are; they can be covered only by taking a comprehensive diagnostic view of the whole oyster ation, biological, technological, economic and perhaps sociological, and d habits of the people, to discover just what has been holding the industry k. There are rather strong indications that there are numerous hindrances ong which is the blowing and washing process, which will be solved by hnological research concerned with the chemistry and conservation of the nescent but elegant flavor of the oyster, for it is well known to executives the food industries that palatability and delectability are more potent deter-nants of food consumption than nutritive values and "health appeal."

Thus, not only in the oyster industry, but in the whole field of fisheries search, the vitally important work of comprehensive examination and analy-i of the complex and delicate web of economic-biological determinants is ting to be performed to discover what and where the really critical prob-s are.

We mention here only a few in the fisheries generally that appear to be his class: In biology, it appears strange that before policies and attitudes e adopted on the basis of supposed scarcities they would have been pre-

ceded long ago by far reaching studies to determine or estimate just what the basic potential yield of fisheries in the accessible water, how it compare with the present and prospective drain upon it, and how the ecological syste as a whole responds to removal of some of the species. Yet no such studi have ever been made or even thought of. We have only the sketchiest knov ledge of the quantitative conversion factors of how much prey is require to make a pound of predator, nor how this over-all average factor of all th many and successive conversions for a fishery as a whole is affected by heav exploitation.

Transplantation and acclimation of desirable species was once extensive practiced without proof one way or another whether it added anything to th total supply of fish or merely increased competition and predation. This fiel if really scientifically studied might have great possibilities, both directly an indirectly. Indirectly, it may be related in an interesting way to the questior Vegetable plankton may depart from this life by dying and decomposing, b sedimentation and fossilization, or by being consumed as food by animal It seems obvious that on land only a very small percentage of the total veg tation ever enters the animal chain at all. If this is so at sea, then interestin possibilities might exist to import suitable phytoplankton consuming crustace mollusks, gill straining fishes, etc., regardless of their direct usefulness, so a to build up a denser population of any kind of animal life at the base of th food pyramid which could, in turn, support larger populations of the kind of larger animals that are useful to man.

There is a field of the very greatest importance that should afford opportuni for most fascinating and fruitful work for years to come in the study of sen organs, reactions and responses to all manner of stimuli and general tele logical and "psychological" behavior of fishes and other marine anima with a view to devising more effective methods of finding and catching them Among these are sounds of different frequencies, intensities and timbre, co stant and intermittent, light and electric fields similarly varied in all the respects, gradients of temperature, salinity, oxygen, CO_2, chemical emana tions that may be followed by fishes in pursuit of their prey, sex lures, d rective influences in migrations, etc, etc. Such researches should be accor panied by the parallel researches in the engineering design of traps, ne shelters and other gear made possible by the many new materials and tec niques now available. If methods of catching were devised which are bo selective at will and could coax or drive large volumes of fish into captiv not only of edible but trash fish at low enough cost to make them profitab they would go a long way not only toward establishing a better competit balance in the water but adding to the revenue of the fisheries.

The chemistry, pure and applied, of food flavors, especially the savo meaty and salty flavors, and the delicate savory substances in lobster, cla mussels, caviar, shrimp, roes, fish fats, etc., has not had attention. The c servation and manipulation of these substances in sea foods, and perh their identification and synthetic production and use as lures in the catch of fish can be of great importance. Further along this line is the whole fi of scientific cookery, including the softening of bones without removing th for, as said earlier, people eat first what they like and, second, what is g for them and cheap.

Extensive studies should be carried out in fundamental fishery econom such as was barely begun in our North Carolina Survey.

Northern Markets for Southern Seafoods

SPENCER A. LARSEN, *Director, Materials Management Center, Wayne University, Detroit, Mich.**

HERE ARE PRODUCED ANNUALLY in the South Atlantic and Gulf area fifty to xty million pounds of fish (mullet, grouper, mackerel and snapper), a large ortion of which is entitled to a better market opportunity. Only a small part the present catch is finding its way north and then primarily because eople who have moved from the South to the North seek out these native me-known varities in the retail markets.

Wholesale and retail markets in the north and midwest, anxious to supply afood demands of their customers, and at the same time serve shippers, e struggling against great odds because of the manner in which quantities southern seafoods are prepared and transported to market. The fresh fish at are now shipped in cumbersome barrels with ice as a refrigerant fre-ently arrive in deplorable condition, causing leading fish merchants to oid fresh fish from the South.

Mr. Harry Botts of the Warren Fish Company at Pensacola, mentions some the marketing problems of southern fisheries in a personal communication. r. Botts says, "Grouper is a good fish. It is fully the equal of most other rities, except red snapper and a few others. Yet it is salable only in the utheastern states. I venture to say that 75 per cent of the red snapper rved in Pensacola and the Miami areas is actually grouper. In Memphis, ouper is 'tenderloin trout.' In Nashville it is 'gray snapper.' Since grouper good enough intrinsically to pass as snapper with the uninitiated, there is reason why it should not command a market in its own right. Spanish ackerel is another fish which definitely needs promoting. For some reason ackerel has lost much of its popularity during the past five or six years.

"While the shape of both snapper and grouper is such that they cannot filleted without excessive loss in weight, this is not true of mackerel, which et very economically. Yet, despite the increasing acceptance of north lantic fillets, we have never been able to move any worthwhile amount of ackerel fillets."

Mr. Botts further states, "We are particularly interested in the results of a rvey in trends of merchandising fresh versus frozen seafoods, as well as attitudes of various types of store managements towards handling sea-ods—especially fresh seafoods."

The above questions, raised by Mr. Botts, are perhaps typical of those many seafood houses in the South. Moreover, it was found after making rounds of seafood markets (wholesale and retail) in Detroit and Cin-nati, that there are answers to these questions.

First, the extent to which each of the several varities is sold in 200 large ermarkets in Detroit should be noted. The percentage of the total volume, pounds, accounted for by each variety is given in Table I. It will be seen t five varities (cod, haddock, rosefish, smelt and shrimp) account for 67 cent of the total sales. Shrimp, with 9.6 per cent of the total, is the only n from the South among the first five.

t is not known exactly where the fish represented in Table I come from, aside from shrimp, some lobster and possibly mackerel, it is evident t very little comes from the South.

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ontribution No. 70 from the Marine Laboratory, University of Miami.

Next, let us see what the men who make the buying decisions have t say about southern seafoods. No opinion is offered as to whether they a right or wrong, but this is an accurate interpretation of their forthright an

TABLE I

PERCENTAGE DISTRIBUTION OF SEAFOOD SALES BY A REPRESENTATIVE CHAIN RETAIL ORGANIZATION—1951

Variety	*Per Cent of Total Weig*
Cod Fillets	18.1%
Haddock	15.1
Ocean Perch or Rosefish	13.0
Smelt	11.1
Shrimp	9.6
Halibut	5.8
Whiting	3.2
Yellow Pike	3.1
Herring	2.7
Perch	2.4
Mackerel	1.75
Northern Pike	1.6
Squid	1.6
Whitefish	1.6
Salmon	1.2
Flounder	1.0
White bass	0.9
Sheepshead	0.8
Lobster Tails	0.8
Frog Legs	0.8
Cherry Clams	0.6
Scallops	0.5
Catfish	0.5
Bullhead	0.5
Blue Pike	0.5
Lake Trout	0.25
Lobster	0.1
Miscellaneous	1.0
Total	100.0%

well-considered judgments which surely influence their buying decisions.

Frank Clatworthy, head of fish buying in the Great Altantic and Pac Tea Company's North Central region, with a long and successful career in business, gave the following appraisal of the situation:

"Southern varieties of fish have good acceptance as far north as Louisv Beyond this point there is no real demand except among the negro popula and persons who have migrated from the South. The main reason for thi that southern producers have packed fish the easy way and they have packed it well enough to get it as far north as Detroit in good condition. Th is a lot of barrel packing, with barrels containing 150 to 200 pounds of and not nearly enough pre-chilling. Barrel packing results in too many di trous shipments. With three layers of ice, and fish in between, there simpl not enough refrigerant to hold them at a low temperature. This is especi true in warm weather. Also the heavy weight in barrel packing means that fish in the bottom are badly crushed. If the southern fisheries insist u

hipping their fish in this kind of a pack, then we can't hope to get them eyond Louisville in good condition. It's simply a matter of too much fish, too ttle refrigerant."

Continued Clatworthy, "There is a lot of good southern shrimp available, et some dealers are still shipping shrimp of very poor quality. The careless ractices of these shippers lessens our confidence in southern fish in general. panish mackerel is an example. This is a good item because the fish are small nd can be sold whole. It has a beautiful silver color which is attractive in the ase. It should, therefore, sell well. But its salability is adversely affected ecause of the inferior way in which it is packed, together with the long eriod of time it is in transit.

"King mackerel is not such a good item for us to handle because it is large nd has to be cut up. When it is cut the flesh shows blue, which detracts from s sale.

"It has been our experience that southern oysters do not ship well because ey come out of warm water. If this is not true, then there is need for re- lucation on this point. But there is one item, lobster tails, on which they are oing an outstanding job in the South. Our business on this item is on the crease.

"But frankly," said Clatworthy, "I do not believe that southern fishermen ke the trouble to pre-chill the fish as soon as they catch them. Thus much the damage is done before they are packed. If they would thoroughly pre- ill the fish on the boats as soon as they catch them, and if the dealers would ep them in a chilled room at 32° F. and then ship them North in refrigerated rs or trucks, the fish would arrive in good condition."

Fresh Versus Frozen Seafoods

Except for locally caught varieties most of the fish coming into the Detroit arket are now being frozen. Prominent food chains in Detroit, such as the roger Company and Wrigley's, are firm in the belief that they fare better merchandising exclusively frozen seafoods of high quality. Rad B. Scott, roger's Detroit meat merchandiser stated:

"Regardless of the size of our stores we are limited as to space. At the esent time 102 of our 146 markets in Detroit area have only low tempera- e cases. There are *no* fresh fish being sold in any of these markets. During e past year we have opened twenty new supermarkets. In only one of these arkets have we installed a fresh fish case. A few years ago when Kroger ened a new supermarket it would install three to five low-temperature cases all frozen goods in the store. Today we install 10 to 20 such cases, depend- g upon the size of the store.

"The trend in Kroger's fish merchandising operation is toward reducing ndling and processing costs by buying seafoods in a form that is easy and tomatic to handle—as far as possible on a self-service basis. This eliminates bles, electric scaling machines and other specialized equipment, and allows to make better use of space. Then, too, we want to present a clean-looking eration to our customers and one that is agreeable to our employees. Store nagers, regardless of whether or not the fresh fish operation is successful, k it down and present a good case for de-emphasizing fresh fish in our plan store operation. Finally, shipments to outlying stores, especially during rm weather, present a problem of temperature control.

"The fact is that while we are changing our equipment to a frozen seafood is and playing down fresh fish advertising, but still doing as much seafood vertising as ever, our seafood sales are higher now than they have ever been."

Wrigley Markets, now the third chain in size in Detroit, sells only froze seafoods. This aggressive chain recently purchased the Packer Outlet chain c supermarkets, and this is becoming an increasingly important factor in foo retailing in Detroit.

The Great Atlantic and Pacific Tea Company is pursuing a slightly differe policy, but is nevertheless moving in the same direction as other retail outle in the area. Strictly fresh fish are now on about a fifty-fifty basis with froze fish in the northern central region of A & P Food stores, with the trend notic ably toward the frozen product. Most of the fish that is being sold fresh com from the nearby lakes.

Store managers in the A & P organization prefer the frozen product becau it eliminates the headaches from "policing" quality, especially when fresh fi fail to move promptly. Also the frozen product simplifies housekeeping pro lems by eliminating objectionable odors and unsightly conditions incident cleaning fresh fish. Although A & P Food stores do not like to handle fre fish, it appears, nevertheless, that this food chain is moving more slowly tha other retail outlets in the area toward a complete frozen seafood prograr Some of their customers definitely prefer the fresh product. Besides, A & P particularly well set up to obtain fresh fish supplies from nearby sources.

Before leaving the subject of fresh versus frozen fish, it may be of intere to note the proportion of each kind of fish being sold in the afore-mention 200 supermarkets. This is shown in Table II. A glance at the first five (co haddock, rosefish, smelt and shrimp) again suggests the heavy trend to froz seafoods, except for local varieties.

Mr. James Bay, General Fish Merchandiser for the Kroger Company Cincinnati, sees definite obstacles in the way of marketing certain varieties southern fish. Fatty varieties, he points out, are not well suited to freezir and certain other varieties cannot be supplied in quantity on a regular bas Kroger likes to have a constant flow of supply.

Fisheries in the South, in the judgment of Mr. Bay, will have to make t following adjustments if certain varieties of their fish are to find a market the North: (1) Build a modern all-weather fishing fleet (2) Develop prop filleting and consumer packages appropriate to southern varieties. A packa of frozen fish should contain one pound, and suggest a sanitary high-qual type of product. The package need not look gaudy and picture windows a not necessary (3) Provide adequate flash-freezing facilities and cold stora space. (4) Develop containers and other shipping facilities that properly pr tect the product in transit.

The Way Out

There is only one way for the industry to win out in the fish marketi business—produce *quality*, and the fishery that succeeds on any other basis do it at the expense of the industry. As A & P's Frank Clatworthy recently marked, "The fishery that places on the market, day in and day out, fish high quality is always oversold."

An intriguing method of processing an unusually high quality of shrimp the South is being applauded by northern distributors and their custome This high-quality seafood, now getting into volume production by Seap Corporation, St. Simons Island, Georgia, grew out of Wayne University's stu "Markets for Airborne Seafoods." The process consists of de-heading a quickly pre-cooling the shrimp on the boat. Upon landing they are peel de-veined, washed and then individually suspended by the tail and flash-froz The result is a package that looks like a box of waxen lilies. The appearan

TABLE II

PERCENTAGE OF RETAIL SALES BY A REPRESENTATIVE CHAIN OF STORES OF FRESH AND FROZEN FISH—1951

Variety	PER CENT BY WEIGHT *Fresh*	*Frozen*
Cod Fillets	16.6%	83.4%
Haddock	21.	79.
*Ocean Perch or Rosefish	. . .	100.
Smelt	28.6	71.4
*Shrimp	. . .	100.
*Halibut	. . .	100.
*Whiting	. . .	100.
Yellow Pike	74.5	25.5
Herring	100.	. . .
Perch	67.1	32.9
Mackerel	81.9	18.1
Northern Pike	100.	. . .
*Squid	. . .	100.
Whitefish	100.	. . .
*Salmon	. . .	100.
Flounder	69.7	30.3
Sheepshead	100.	. . .
*White bass	40.	60.
*Lobster Tails	. . .	100.
*Frog Legs	. . .	100.
*Cherry Clams	100.	. . .
*Scallops	33-1/3	66-2/3
Catfish	100.	. . .
Bullhead	100.	. . .
Blue Pike	56.6	43.4
Lake Trout	100.	. . .
Lobster	100.	. . .

Note: Varieties of fish starred in the above table are all brought into the store in frozen form but may be sold either frozen or unfrozen. There was no way of determining how much of each variety was sold frozen or unfrozen.

nd eating quality are excellent. These shrimp, both plain and breaded, are ow being distributed in major cities over the country, principally for insti- ıtional and restaurant accounts, in three pound packages. Daisy Valley Foods ompany is at present the one Detroit wholesale outlet. The product, sold nder "Aero" brand, is sold at a current price of 97 cents per pound (15-20 ze) for both the peeled, plain de-veined shrimp and the breaded version. his price may seem out of line for the wholesale price of shrimp, but not ne of the several users questioned had any complaint on price or any other spect of the product.

The Howard Johnson restaurants in Detroit have been using this brand of ırimp during the past three months and openly praise it. They state that it is ıe cleanest, most convenient type of shrimp they are able to buy and that their ost experience is most satisfactory. They know exactly where they stand on ost because they know that each shrimp is costing them four cents. Thus, if ıey serve four shrimps, the cost is sixteen cents, and if they serve five their ost is twenty cents per serving.

Typical of other accounts in Detroit now using this shrimp are the Fo Motor Company and Greenfield's restaurants. In general these accounts thi very highly of this product because it saves them time, labor and mess in t kitchen. Remarked Ford's food buyer, "The product must be good or I'd getting kicks from the kitchen."

The head dietitian of Greenfield's restaurants in Detroit was emphatic her observations. She remarked that while the price may seem high, actual when the labor saved was taken into account, the price is reasonable. Th restaurant is thoroughly satisfied and intends to use the shrimp in increasi quantities. Greenfield's now have their supplies trucked directly to their freez

More specific evidence of the market acceptability of the product is fou in the actual sales of Daisy Valley Foods, a small but progressive wholes house that took on distribution of this product three months ago. During t first month they offered it for sale, the total volume was 7,000 pounds; t second month, 12,000 pounds; and the third month, just closed, 16,000 poun Volume on these products has now increased to the point where this Detr wholesaler is able to order in truck load quantities of 20,000 pounds.

During the past few years the industry has become increasingly conscio of the need and opportunities to improve methods of packaging, materi handling and distribution. And nowhere, perhaps, are there such wide-op opportunities for increased efficiency in packing, handling, storage and tra portation as in the fishing industry. Farms, mines and factories are rapi adopting new and more efficient ways of handling and moving materia Products of these industries are bulky and heavy and, like the products of t fishing industry, run into millions of pounds annually. It seems safe to pred that just as machines have made obsolete old methods and tools for maki things by hand, so will modern improved technologies for moving and han ling fishery products render obsolete a vast amount of investment in plan warehouses, packaging and transportation equipment.

Obviously, modern materials handling equipment cannot be used in co junction with existing plants and facilities in the fishing industry. While ma will think it an extremely rash statement, nonetheless, the only hope seen t adapting many of these old dilapidated buildings to modern methods of m terials handling is to tear them down and start all over again.

Moreover, it does not seem wise for the fishing industry to tie itself t closely to the railroads if this mode of transportation persists in transporti products in the same old ways that they have done since the horse and bug days. Railroads were, of course, built long before engineers began to think the best ways to move materials. If they were to take full advantage of t new low cost techniques they would have to scrap a large part of their equ ment and redesign it.

For certain products it is not apparent how railroads can hope to comp with the motor truck and airplane which are far more flexible in their ope tion, and which are being constantly redesigned for more efficient handli scheduling and temperature control. While cargo planes still have their pr lems, nevertheless, for many hauls they travel the shortest and most dir route and can pick up merchandise at the point of production and lay it do in a fraction of the time at the point of consumption, often at lower net c than for rail express.

Large quantities of Great Lakes fish that once went to New York via express, have in recent years moved by airfreight or truck which has sa

ne as well as handling and packaging costs. The handwriting is on the wall far as the railroads and certain types of traffic are concerned.

Detroit is taking these packaging and materials handling functions seriously -so much so, in fact, that in them is seen the keys to future industrial success. Del S. Harder, Vice President in Charge of Manufacturing at the Ford otor Company, in cooperation with executives from General Motors, Chrys-, and other leading industrial concerns, is assisting Wayne University in-stigators in the establishment of a research and training center which plans explore these new frontiers. Over $300,000 is to be spent on a research and ining program during the next five years.

If Detroit industry, one of the most efficient production centers in the world, els the need of improving its methods of packaging, materials handling, rehousing and transportation, then what about the fishing industry? To be re, the tonnage handled by this industry is spread over a great many more ms. Nevertheless, it is in much the same category as some of the heavy indus-es that are now tremendously concerned over the opportunities to reduce sts further through improvement of these functions of physical supply.

The statement was made recently by Mr. Harder: "Materials handling is in infancy. Before we started our materials handling program at Ford's we ndled our scrap at the foundry by using men, wheelbarrows and overhead nes. It took 112 men, 100 wheelbarrows and 12 cranes. Now, by using lustrial power trucks and special hoppers we do the same work with 36 men. e saved enough in 80 days to pay for the equipment, and these new methods saving the company on this one operation alone over a quarter of a million llars annually!"

There are numerous other examples to prove dramatically that industry in s country is on the march toward lower costs of operation through improved thods of packaging, handling, storage and transportation. The fishing in-stry must also ride this swelling tide.

By way of conclusion, it may be said that increased market opportunity for uthern varieties of seafoods depends upon a steady supply of top-quality sh-frozen seafoods, attractively put up in packages of appropriate size for titutional and retail trades, properly refrigerated, efficiently handled and nsported with modern low cost equipment. When it is realized that a high-ality product will command a premium price in the market that will give uthern fisheries millions of dollars of added financial return for their efforts, n and only then will the industry invest a portion of this prospective revenue new equipment for processing, packaging, materials handling and refrigera-n so as to safeguard the quality of the product all the way from the water the consumer.

TUESDAY, NOVEMBER 13

Chairman—DAVID A. WALLACE, Director, Oyster Institute of North America, Annapolis, Md.

Winter Growth of the American Oyster Crassostrea virginica in Apalachicola Bay, Florida

ROBERT M. INGLE and CHARLES E. DAWSON, JR., Florida Oyster Division

*Abstract

It has previously been established that the American oyster grows only during the summer months in northern waters, and that growth in general i approximately an inch a year.

In Florida, growth is continuous throughout the year and, in optimum ecological circumstances, is greatly accelerated. For instance, this study revealed an average growth (under favorable circumstances) of 2.7 inches during th period of June 6, 1949 to February 21, 1950. In the period September 9, 194 to March 3, 1950, largest oysters (average size: 3 inches) grew one inch, o to an average size of four inches.

Because of its rapid and continuous growth, the Florida oyster holds grea potential for scientific cultivation and exploitaton.

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Report on the Attempted Introduction of the Virginia Oysters Crassostrea virginica into the waters of Puerto Ric

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IN PUERTO RICO there is found only one species of edible oyster, the sma "mangrove oyster," *Crassostrea rhizophorae* (Guilding). These are fou attached to the aerial roots of the common mangrove which border the ban of various lagoons and other protected shores where there is little exposu to open waters. Many connoisseurs of sea foods insist that the flavor of t mangrove oyster is superior to that of *C. virginica*, and it is greatly soug after as food. From one lagoon, at Boqueron, it has been estimated that fr 25 to 30,000 pounds of these oysters are harvested annually (Mattox, 194 To augment this production it has been suggested that the "Virginia oyst *C. virginica* should be brought into Puerto Rico. Attempts have been ma to do so.

Through the courtesy of Dr. Philip A. Butler of the U. S. Fish and Wildl Service three shipments of seed oysters of *C. virginica* were sent from Pen cola, Florida to Mayaguez, Puerto Rico by Air Express. The average length time in transit from Pensacola to Mayaguez was three days. Upon arrival t

ere immediately planted. The oysters were inspected immediately after arrival d all dead animals were removed. The remaining living animals were dis- buted among several wire baskets and then placed in one of two lagoons. me were placed in a lagoon at Boqueron where *C. rhizophorae* is very abun- nt, and others were placed in a lagoon at Joyuda where there are no other sters. The planted oysters were observed regularly as to mortality and idences of growth.

The first shipment was planted in the Boqueron lagoon on January 3, 1950. n arrival approximately 50 per cent of the oysters were dead, probably killed temperature changes suffered during transit. The remaining living oysters, in number, were planted in a series of wire baskets among colonies of *C. izophorae* at the average low tide mark. One week after being introduced ly 22 of the original 50 oysters were living, a mortality of 56 per cent. From is period there was a gradual drop in number of living animals until after months, July 1950, when all were dead.

The second shipment arrived in better condition with approximately 10 per nt being dead on arrival. These oysters were planted in the Joyuda lagoon on ay 11, 1950. After 2 weeks the original number of 135 had dropped to 59, presenting a mortality of 57 per cent. These oysters also gradually died until ter a period of five months, October 1, 1950, all were dead.

The third group was received and planted on October 13, 1950. They were aced in the Boqueron lagoon. These oysters were larger than those in the her groups, the largest being nearly 70 mm in length. After three weeks there as a drop from the original number of planted oysters of 168 down to 86, a ortality of 49 per cent. Members of this group were all dead after 7½ months June 1, 1951.

In all three groups the initial drop in numbers during the first few weeks ter transplanting was probably due to the shock received during transpor- ion which weakened them to a point beyond which they could not rapidly cover. Only in the third group was there any noticeable growth of the shell d that was very little and at a slow rate. In this group marked oysters in- eased in shell length only 6.6 mm. in 6½ months. This rate of growth is normally slow for *C. virginica* in warm waters. Ingle (1950) indicated that *virginica* living in the Apalachicola Bay area of Florida would make ap- oximately this same growth durng one month. *C. rhizophorae* living in the queron lagoon would reach a size of approximately 50 mm. during a similar riod. There was no indication of the production of spat by any of these sters.

The environmental factors under which these transplanted oysters were ced were all within the normal range of tolerance of this species. At Boque- n the temperature variation was from 25 to 31°C., approximately the same the mean temperature during summer months at Apalachicola Bay, of °C. The salinity was higher than the mean of 26.3% at Apalachicola Bay as varied here from 26.5 to 38%. This may possibly be a factor in the high rtality. The pH at Boqueron averaged 7.7.

In the Joyuda lagoon the temperature variation was from 27 to 31°C. The inity in this lagoon is lower than at Boqueron, it varied from 25 to 29% ring the period when these oysters were present. The pH was slightly higher, h an average of 8.0.

The question of the cause of the rapid mortality of these *C. virginica* intro- ced into the waters of Puerto Rico has not been answered. Plans for further troductions and close observations are being made.

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A Criticism of Oyster Measurements

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There are surprisingly few papers among the vast amount of oyster lit ature which give measurements on oysters. Among those which do gi measurements a high proportion report length of oysters in tenths of a mil meter. An article in a Bureau of Fisheries publication, one in the Americ Naturalist, one in a Canadian publication, and two fairly recent articles Science, give the length measurements of oysters in tenths of a millimet Further, within the year, two manuscripts have been submitted to the wri for criticism in which comparative growth rates of oysters have been giv with the length measured in tenths of a millimeter. Such measurements a really too "accurate" to be accurate.

Measuring the length of oysters to a tenth of a millimeter should not attempted because of the very nature of oyster growth, because of the limi tions of the instruments used in making the measurements, and because o time-growth element which should enter into the measurements.

Those familiar with the rapidly growing oysters of the Gulf and So Atlantic coasts realize that, in time of rapid growth, the bill of the oyster m consist of as much as three to five millimeters of extremely thin, britle, pliable chitin-like shell. In gathering specimens for measurements, injury likely to occur to this thin bill. It is extremely difficult to determine by or nary observation whether or not small parts of this fast growing oyster have been broken off. Assuming that the specimens for measurement can and have been hand-collected, this very flexibility of a fast growing oyster makes it readily subject to distortion if even only a small amount of press is applied when the length of the oyster is measured with a vernier calip Accuracy of measurement to a tenth of a millimeter seems somewhat dubi under these circumstances.

A measurement or a weight can be only as accurate as the instruments u to weigh or measure. If the measurements of oyster lengths were made by of an ocular micrometer in a binocular low power microscope, measureme down to one-tenth of a millimeter certainly would be accurate. Undoubte however, the vast majority of oyster length measurements are made wit standard vernier caliper. It is extremely doubtful that any of these have b standardized by the U. S. Bureau of Standards. Although their accuracy probably relatively good, two such calipers bought from the same compa but at different times, were compared recently at Bears Bluff Laboratories. of these calipers is inaccurate to one-tenth of a millimeter. While this accuracy is small, nonetheless it is sufficient to influence oyster measurem which are given in tenths of a millimeter.

Robert Ingle's publication in Science (Vol. 112 No. 2908, pp 338-339) the "Summer Growth of the American Oyster in Florida Waters" surpr

me oyster biologists who were familiar only with growth rates of oysters in e colder North Atlantic waters. Although we in South Carolina have no long ries of oyster growth measurements exactly comparable to those given by gle, we have some measurements (admittedly our best) which virtually nfirm Ingle's records. Averaging our best measurements a growth rate of 56 millimeter in a day has been found. An average of Ingle's figures gives mathematical growth of 0.688 millimeter in a day. Assuming (erroneously be sure) the growth rate is continuous and constant during the day, from e above figures, the conclusions reached are that Bears Bluff Laboratories' sters grow at the rate of 0.023 millimeter per hour and that Ingle's oysters ew at a rate of 0.028 millimeter per hour. This seems to be mathematically curate even though it is extremely doubtful that it occurs thus in nature. ow suppose that a series of oysters are taken for measurements beginning the morning at 8 o'clock. Sampling continues periodically through the day til the last oyster taken for measurement is secured at 1 o'clock. These sters are held out of water until they can be measured. For absolute accuracy would be necessary to record the time at which the various specimens are ken. Since, mathematically and theoretically they are growing at the rate of most a 0.03 millimeter per hour, the oysters taken at 1 o'clock would have d an opportunity of growing more than a tenth of a millimeter in the inter- l of time between the taking of the first oyster at 8 o'clock and the last oyster 1 o'clock. Thus a time-growth element should be taken into consideration if easurements are given to an accuracy of a tenth of a millimeter.

Growth Rates and Movements of Hard Clams, Venus mercenaria

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Among the numerous observations that have been made of the growth rates various species of pelecypods there are but few references to growth studies hard clams, *Venus mercenaria*. These references are limited to studies in the rthern range of *Venus*, from New Jersey northward. Kellog (1903) made me preliminary studies at Cold Spring, New York with small clams 2.8 to 4 centimeters in length. Unfortunately his experiments were continued for ly six months from June to December, but the results clearly demonstrated e rapidity of growth in *Venus* with an increase, in some cases, of 225 percent volume. The extensive plantings made by Belding (1912) in Massachusetts re followed for four years. The growing season in Massachusetts was found extend from May to November when water temperatures were above 45°F. rious ecological factors such as current tides, depth of water, salinity, type soil and temperature were found to influence the growth rate. Under favorable nditions Belding recorded clams growing two inches in length in two and le-half years from time of setting, to two and one-half inches in three and e-half years. He estimated that sixteen years would be required to produce a m four inches in length. Haskin (1949) concluded after one growing season t the results in Delaware Bay, New Jersey checked almost exactly with those Belding at Wellfleet, Massachusetts, The present study was undertaken to

determine the growth rates of this species in North Carolina and to secu information on procedures for future experiments.

Two areas were selected for the plantings in North Carolina, the beach at t Institute of Fisheries Research along the north shore of Bogue Sound, and small cove one mile across the sound on the opposite shore. Both areas a approximately five miles west of Beaufort Inlet.

The north shore of Bogue Sound in this locality consists of a sand botto and is exposed to the prevailing southwest winds. In contrast, the irregular sou shoreline with the bottom varying from soft mud to hard sand is broken b many marsh islands and meandering tidal streams. A soft mud bottom w selected for the south shore plantings where an abundant supply of clams w found.

Acknowledgement is made to Mr. William A. Ellison, director of the Ins tute of Fisheries Research for his interest and suggestions, and to Mr. Teichroew of the University of North Carolina Institute of Statistics for helpf advice in planning the experiments. For technical assistance in measuring a compiling data, the writer is indebted to Mr. Leigh Winslow, a former memb of the Institute staff and to Dr. William E. Fahy who performed the statisti t-tests and analysis of variance.

Methods

In December, 1949, a total of 359 clams were collected for the experimen 63 from the north shore and 296 from the south shore. The number of cla obtained from the north shore was limited because of the sparse populati Each clam was notched with a file and a number cut in the shell with a den drill. Duplicate plantings of clams, selected at random, were made at a conc tration of three clams per square foot in a square yard using only the cla native to the immediate area. The plantings were made in the intertidal zo where the bottom is exposed during extreme low tides. The clams varied length from 2.7 to 10.1 centimeters with smaller size groups absent since animals were gathered with a rake. An additional series of clams from the so shore were transplanted from their natural environment of soft mud to a ti pond of hard sand bottom about three hundred yards from the original locati

Monthly measurements, except for November, were made of the individu of one plot in each area, with the duplicate plots left as controls to be measu at six month intervals. Three measurements of each clam were made w vernier calipers to obtain the length, the anteroposterior axis from the reg of the siphons to the opposite end; the width, at right angles to the length, fr the umbo to the greatest curvature of the shell on the ventral edge; and thickness, on a perpendicular axis to length and width or the distance thro the valves from the outer shell surfaces. The previous studies of Kellogg (190 Belding (1912), and Haskin (1949) have shown that an increase in length d not actually express the gain in bulk. However, Haskin has shown that w width, thickness or cube root of the weight is plotted against length a stra line results. This indicates that little or no change in proportions takes plac the animal grows. If one average dimension for a group of clams is known other dimensions can be obtained from a prepared graph. In the results sented in this study only the lengths are considered.

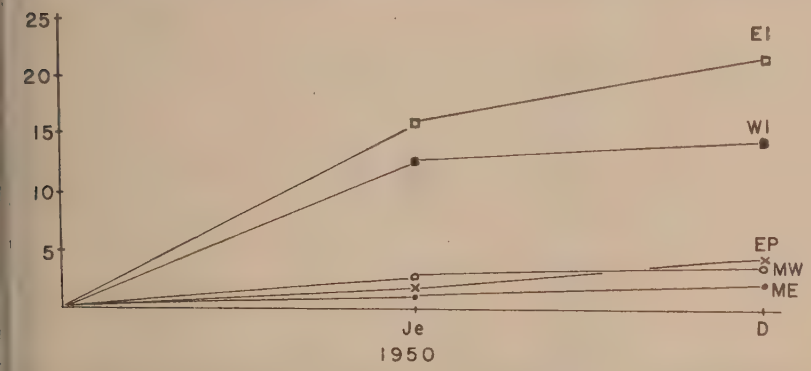
Weekly records were kept of water temperatures and salinities with o sional plankton tows made through the year 1950. Rainfall and air tempera data were obtained from the U. S. Weather Bureau station in Morehead C located two miles east from the planted areas.

Each clam was numbered and a record was kept of the exact positio

/hich the clam was placed in respect to its neighbors in the plot and of the istance moved during each month. Following each monthly examination the lams were returned to their original position and buried in the soil.

Growth Results

The results obtained in 1950 showed wide variations in growth rates between roups of individuals from the two localities. The percent increase in mean :ngth of all individuals within each plot is represented by the graphs in Figure . There was little or no increase in length among the clams from the south nore (Fig. 1, EP, MW, ME) in comparison to the growth shown by the clams



GURE 1. Graphs showing percent increase in mean length of shell at six month intervals for five plantings of clams from two locations in Bogue Sound, North Carolina.

om the Institute Beach (EI, WI). From 87 to 100 percent of the clams from e south shore showed no increase in length or an increase of five millimeters less (see Table 1). In many cases the only visible growth was in filling of e notch filed at the time of planting. Transplantation of a group of these clams om the soft mud bottom to a tidal pond (Fig. 1, EP) did not stimulate shell owth.

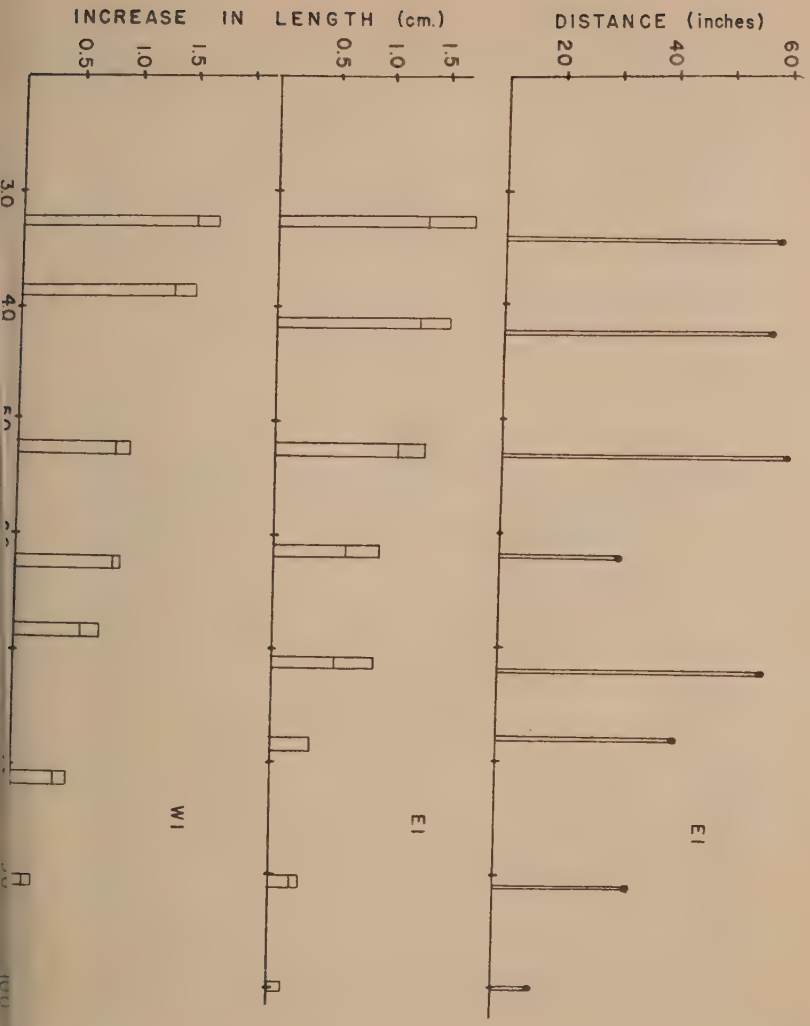
At the Institute beach plantings, the greatest growth was found to occur uring the first six months of the year. Eighty-two to eighty-five percent of the crease in length for the year was from January through June in the east and st plots, respectively. The mean increase in length for the various ten millieter size groups at the Institute beach (EI, WI) are plotted in Figure 2, which cludes the clams that did not grow. The measurements of length increments rough the year in all the plots show a trend of decrease in growth rate with crease in size.

Although growth occurred in all months of the year, monthly variations were und in total gain in length. In Figure 3, the total increment in length for each onth of the year is correlated with salinity, water temperature, and air temrature for one group at the Institute beach (EI). The data show that the owth rate was greatest in April and May, and decreased during the summer onths through September when but two individuals showed any signs of owth. With cooling of the waters in October, when the temperatures were of e same level as in May, there was an increase in growth which decreased in vember and December with a decline of temperature. The values represented November and December are the average of the combined increment for e two months. The heavy rains during July, when 10.9 inches of rain lowered

TABLE 1

PERCENT OF CLAMS FROM EACH PLOT SHOWING INCREASE IN LENGTH AFTER TWELVE MONTHS. PERCENT MORTALITY IN EACH PLOT RECORDED IN RIGHT HAND COLUMN.

Location	*Increase in Length (MM.)*						*% Mortality*
	0	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25	
Inst. Beach							
(EI)	4.1%	16.7%	16.7%	37.5%	25.0%		11
(WI)	7.4	29.6	22.2	22.2	11.1	7.4	25
South Shore							
(MW)	52.2	34.8	8.7	4.3	0	0	25
(ME)	29.2	70.8	0	0	0	0	11
Tidal Pond							
(EP)	43.2	51.0	4.2	0.5	0.5	0.5	21



RE 2. Mean increase in length of shell for different size groups from duplicate plantings at the Institute beach compared with the mean distance traveled by each size group in 1950. The distance from the abscissa to the horizontal line in each bar represents the increase in length for the first six months of 1950.

salinity to 18 parts per thousand (see Figure 3), probably influenced the th rate temporarily.

ne greatest mortality of clams was at the Institute beach where such predas as seagulls and conchs are numerous, (see Table 1). Conchs (*Busycon um*) accounted for 69 percent of the total mortality and seagulls killed remainder. Most of the shells of clams killed by seagulls were recovered

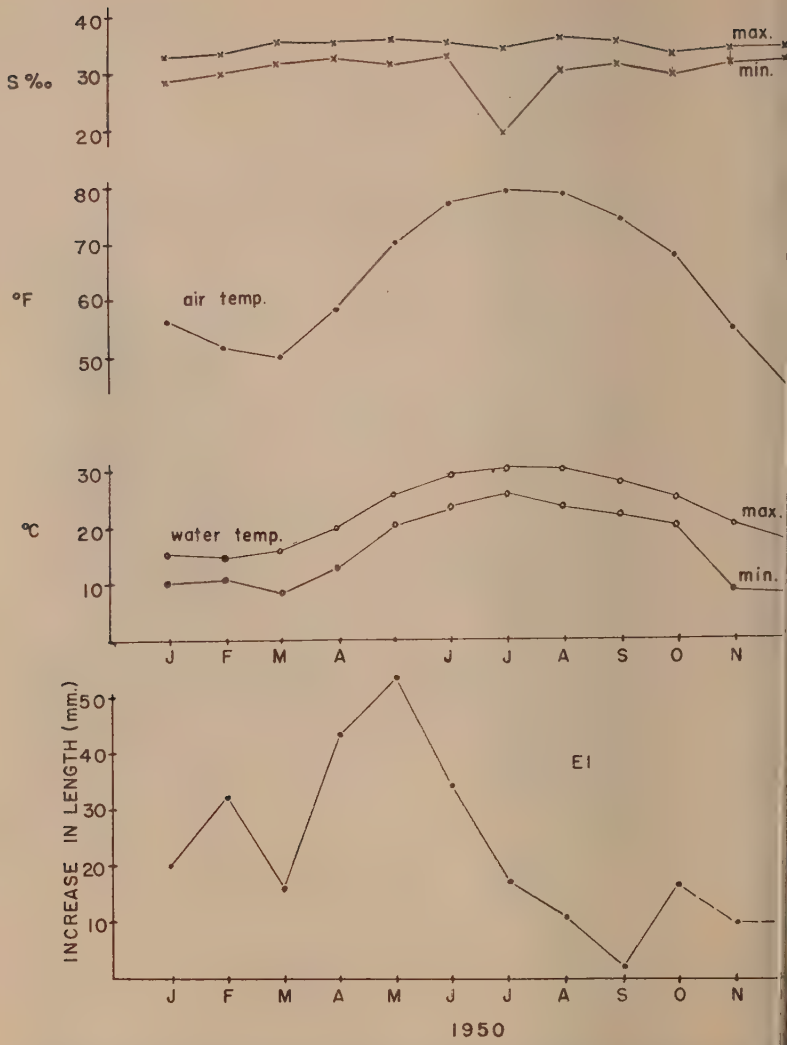
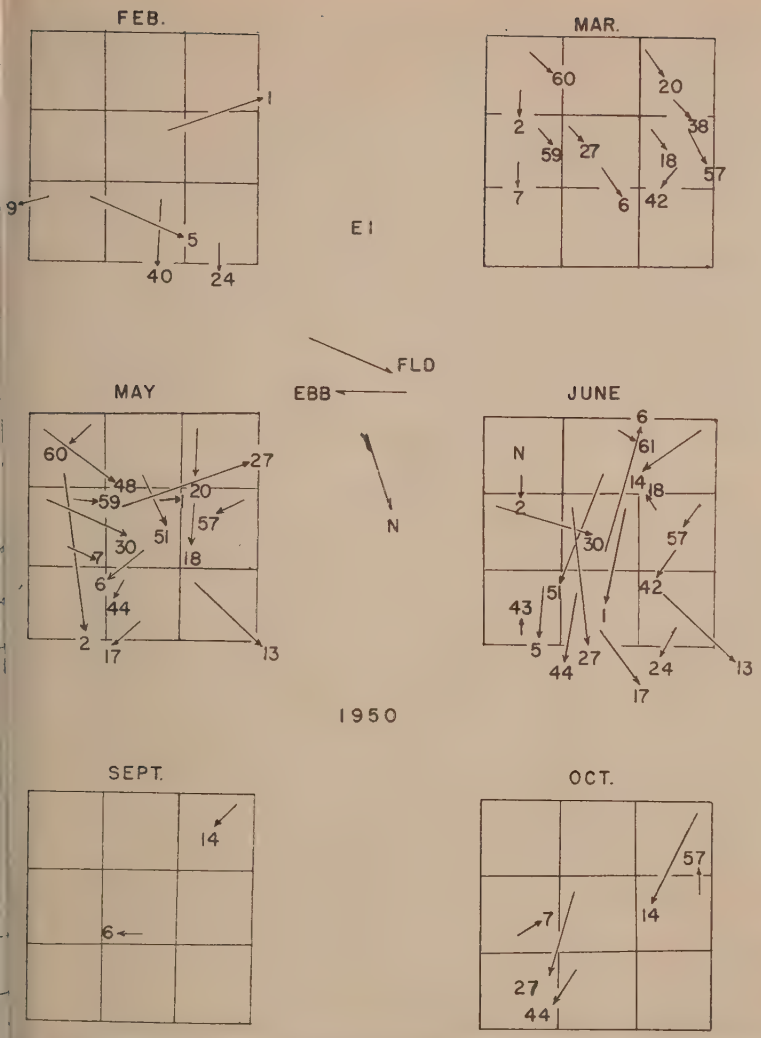


FIGURE 3. Total increment in length for each month at the east plot of the Institute b planting correlated with the mean air temperatures, maximum and minimum v temperatures and salinities recorded in Bogue Sound, North Carolina at the Inst of Fisheries Research.

from the nearby pier where the clams had been dropped to open them. The mortality recorded for the clams from the south shore (MW) resulted transplanting the plot to the Institute beach. All of these clams from the bottom plot (MW) were recovered after the first six months but on transp ing them to the Institute beach in July, 1950, a 25 percent mortality occu in the next six months due to predation.



RE 4. Direction and distance of migrations of individual clams in the east plot at the Institute beach during six months of 1950. The length of the arrows represent the distance between the locations in which the clams were found at the end of each month as compared with the original position. Individuals not recorded were found in the positions in which they were placed. Each block within the area represents a square foot.

Movements

Migrations of some clams were noted each month in all plots examined. Since observations were limited to monthly intervals these results indicate the tion of the clam when it was found in comparison to the position in which ad been placed. At the Institute beach (EI), the movements of the clams ted in Figure 4 for six months were in various directions but predominantly

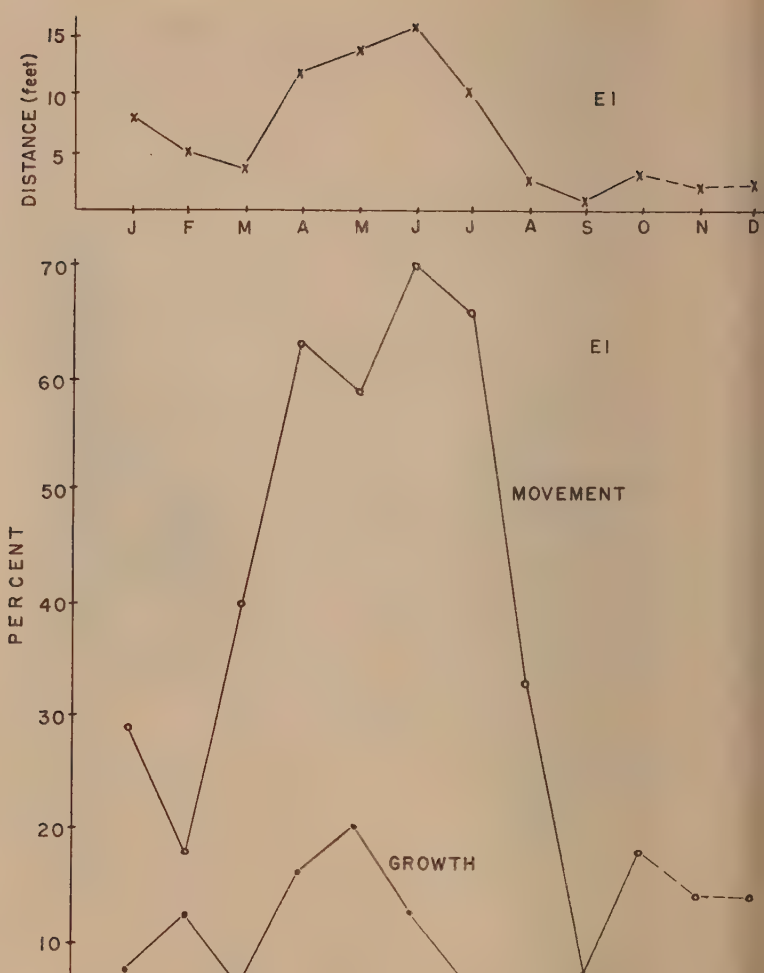


FIGURE 5. Percent of increase in length during 1950 correlated with percent of clams sho ing migrations and the aggregate distance traveled each month by the clams from east plot at the Institute beach. The graphs show that during some months, as in Ma and July, more clams may have moved than in other months but the total distar traveled was not as great. In general the correlation between percent of increase length and total distance of migration is in close agreement.

toward the shoreline. During the year 49 percent of the clams migrated nor ward toward the shoreline, 16 percent in the direction of the flood tide, percent away from the shore and 12 percent in the direction of the ebb ti

In the tidal pond which is protected from rigorous wave action, 36 percent of the migrations through the year were in the direction of the ebb tide, 22 percent with the direction of the flood tide and the remainder were dispersed in various other directions.

The number of individuals moving and the distance traveled each month is compared with the growth rate in Figure 5. The data show that the total distance migrated and the percent of growth was highest in April, May and June. In general the correlation between percent of growth and distance traveled is in close agreement.

Variations were noted in the distances traveled by individuals in the different size groups. A few individuals in the ten centimeter group did not move at all during the year. Among the clams showing signs of movement and the greatest distance traveled during the year was 83 inches for a clam of an initial length of 5.3 centimeters and the least was three inches for a clam of an initial length of 6.2 centimeters. The mean distance migrated in the year is plotted in Figure 2 for the ten millimeter size groups at the Institute beach (EI). Except for the six centimeter size group the data show a general trend of a decrease in distance of migration with increase in size.

Discussion

The abnormal growth rates observed for the clams from the mud bottom along the south shore would indicate that these clams are stunted and possibly dwarfed by the adverse conditions under which they are growing. These clams possess shells that are thickened at the edges, deeply eroded and chalky in nature. These shell characters suggest the presence, in the soil, of an acid condition which may be augmented by the drainage from the surrounding marshland and repeated exposure of the bottom to the air on most low tide periods. Belding (1912) noted the presence of both blunt clams which typically have thickened edges and dwarf clams which exhibit slow growth. The negative results obtained on transplanting a group of clams from the mud bottom to the tidal pond present further evidence that the clams are dwarfed or stunted. Conditions in the tidal pond were found favorable to shell growth when two plots of clams from another area planted at the same time showed an average increase of 1.5 centimeters in length for the twelve month period. It was of interest to note that oysters growing in the mud bottom, frequently with only the edges of the posterior margins of the valves exposed, showed signs of rapid shell growth as indicated by the razor-sharp edges.

T-tests performed between the mean lengths of the clams from the Institute beach and the mud bottom revealed that no significant difference in mean length existed at the start of the experiment. The clams planted in the plots varied in length as would be expected in a random sample of a homogeneous population.

An analysis of variance, shown in Table 2, was applied to the clam lengths of the four plots (EI, WI, MW, ME), from the two different bottoms, at the end of the first six months. To determine whether the variation within each plot, the mean squares ratio of between plots to within plots was calculated. This yielded an F - value of 1.51. Such an F - value has a probability of occurring by chance more than 5 percent of the time in a random sample from a homogeneous population and is therefore considered not significant. When the mean squares ratio of between bottoms to within plots is calculated an F - value of 6.79 is obtained. Such an F - value could be expected to occur by chance in a random sample from a homogeneous population less than five percent of the time and approaches the one percent level of probability, which in this case

TABLE 2

Analysis of Variance of the Increase in Valve Length of 97 Clams (*Venus mercenaria*) from December 1949 to June 1950 in Four Plots on Two Bottom Types in Bogue Sound, N. Carolina.

Source of Variation	*Degrees of Freedom*	*Sum of Squares*	*Mean Square*	*F*	*P*
Between bottoms	1	13.799	13.799	6.79	<.05
Between plots	2	6.131	3.066	1.51	>.05
Within plots	93	189.110	2.033		
Total	96	209.040			

requires an F - value of 6.90, thus the F - value of 6.79 is highly significant. The difference between the mean lengths of the clams growing at the Institute beach and those in the mud bottom is highly significant.

The results obtained from the plantings at the Institute beach are considered as indicative of a favorable locality for growth of clams. Shell growth occurred in all months of the year with the greatest increase in May and the least in September as seen in the graphs of total increment in length and percent of growth in Figures 3 and 5. These results differ from those of Belding (1912) who found that 51.7 percent of the total growth for the year took place in August and September with no shell growth during the winter months of December through April. The difference in water temperature between the two widely separated areas on the coast is probably the greatest factor in determining the relative value of the various months in which growth occurs. Belding does not record any water temperatures except that water temperatures in July 1909 reached 77° F. (25.0°C) in Wellfleet harbor, Massachusetts. Summer, Osborn and Cole (1913) record the mean water temperature at Woods Hole, Massachusetts for the five year period from 1902 to 1906 as 68.8°F. (20.4°C) for July and 69°F. (20.5°C.) for August. At the Institute beach in Bogue Sound, North Carolina the water temperatures were above 22°C. from June through September and exceeded 30°C. in July and August, 1950. These high temperatures are less favorable for general metabolism and might furnish a clue to an explanation of the decreased growth rate during the summer months.

Although the influence of spawning upon the rate of growth was not determined, spawning did occur during the months when the growth rate was decreasing. Well developed gonads with mature eggs and active sperm were found during May. The first clam set was found in the latter part of June and sporadic sets continued through the summer months into November. Belding (1912) found in Massachusetts that spawning occurred in July and August when clams were growing rapidly.

The major portion of the anatomy of the hard clam consists of a well developed foot activly used by the animal to burrow in the bottom and frequently in crawling. In shallow water, clams can often be seen crawling through the bottom leaving a characteristic trail. Kellogg (1903) concluded from his studies that clams do not have any wandering tendencies. Belding (1912) placed 24 clams about a stake and observed the distance of migration at intervals of 3,

14 and 38 days. At the end of 38 days, four clams were missing and fourteen had moved an average of 2.15 inches with a maximum of 6 inches. One blunt clam was reported moving 7 inches in 24 hours. Belding noted all the movements in one experimental bed were in the direction of the retreating (ebb) tide with no difference in the distance migrated between the 28 millimeter and 41 millimeter clams. Belding concludes that the hard clam leads practically a sedentary life.

The present studies have shown that clams do crawl and that the distance traveled is in general correlated to growth rate and size of the clams. In general, the smaller clams were more active in their movements. This was true for the plantings at the Institute beach and in the tidal pond. In the soft mud bottom area the movements were limited to a few individuals usually not more than three clams and in some months only one clam had moved from the original position.

Since the experimental clams had been disturbed in planting it was suspected this may have influenced their movements although several times native clams were found which had migrated into the experimental plots. Thirty clams, 17 along the Institute beach and 13 in the mud bottom, were located in shallow water by their extended siphons while feeding and a numbered wire placed beside each clam. At the Institute beach one clam traveled a distance of 26 inches in 34 hours and four other clams moved from 6 to 8 inches in three months, March through May. None of the clams in the soft mud bottom showed any change in position. All these clams located in their natural position were found to be large clams from nine to eleven centimeters in length, when they were measured after the three months of observations. Since the studies in the experimental plots have shown that the tendency among large clams is to exhibit but little migration, these results with the undisturbed clams are in accord with the observations in the planted areas.

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Sexual Dimorphism in Weight and Length Relationships of the Bermuda Spiny Lobster

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DURING THE MONTHS of January and February 1950, the writer and associates[1] at the Bermuda Biological Station measured and weighed more than 1,000 spiny lobsters (*Panulirus argus*) retained in pounds in Bermuda. These specimens essentially represent a random sampling of the commercial catch of the

[1] The author gratefully acknowledges the assistance of Dr. Louis Hutchins, Mr. Tommy Gleason, Mr. Brunell Spurling and the facilities of the Hofstra College Biology Department in these investigations.

Colony. The following account reports sexual differences in weight-lengt relationships, carapace-abdomen proportions and length frequencies as dete mined from this material. For the smaller size groups (below 90 mm. carapac length) specimens collected from other areas have been used. Previous wor on similar problems have been presented for Florida and Caribbean specimer by Crawford and De Smidt (1922) and Smith (1948 and 1951).

Measurements were taken of the carapace from the anterior margin betwee the rostral spines to the posterior border. The length of the abdomen was als recorded. The weight was recorded in pounds and ounces. In the linear mea surements the accuracy of the carapace length is within one millimeter. Th abdominal length measurement is subject to considerable error as the se ments are flexible allowing varied readings. The telson also becomes frayed torn and the curvature of the abdomen is also a source of error on the al

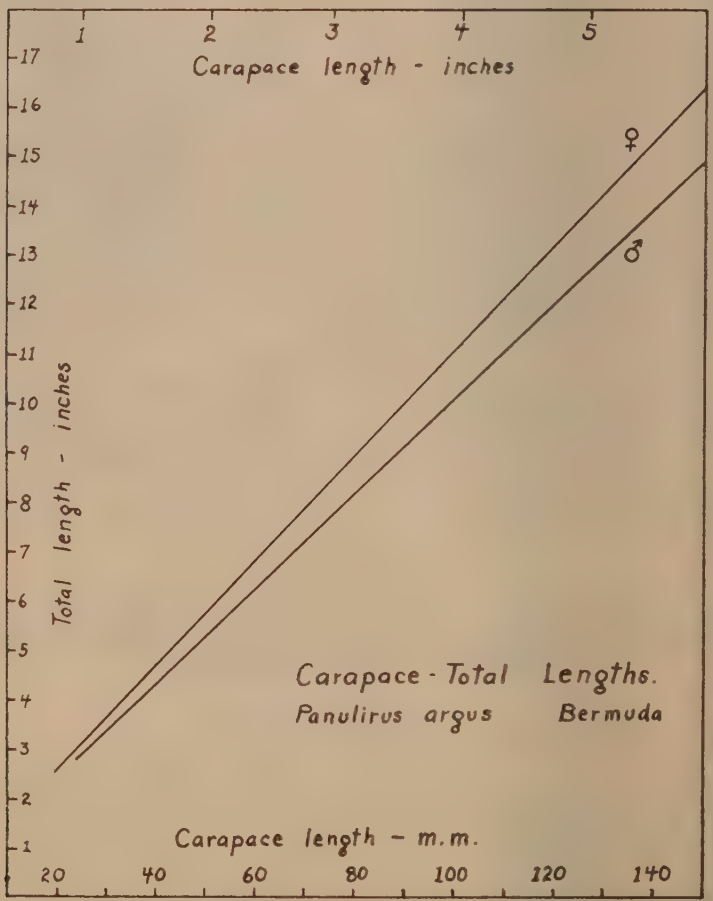


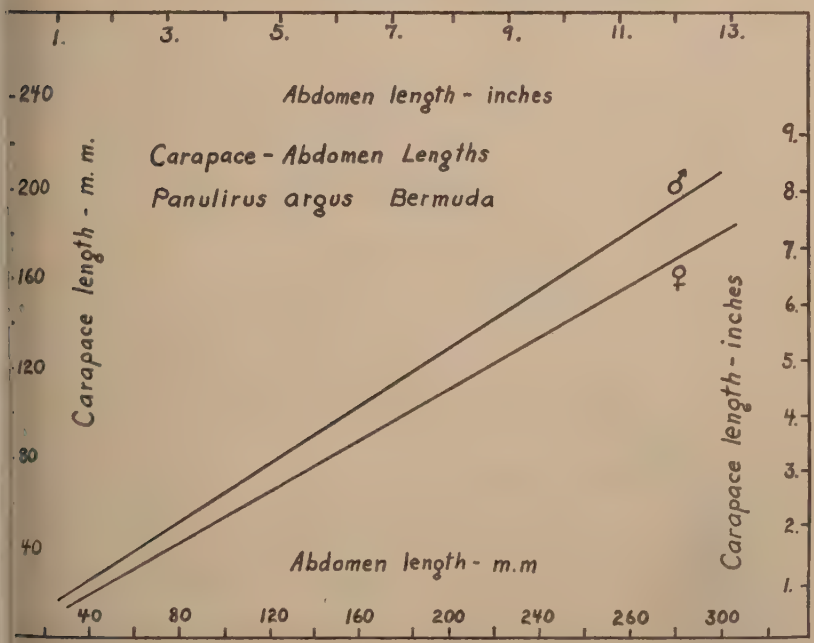
Fig. 1. Total length—carapace length relationship of spiny lobsters in Bermuda, by sexes

dominal measurement. Weight computations are subject to several sources of error. Appendages very frequently become lost. This is particularly true of the antennae which break off when the lobsters are pulled from the pots.

A notable feature of these studies is the sexual dimorphism with respect to body proportions. In female specimens the tail comprises a greater proportion of the total length than in the males. A female 10 inches long, for example, has a carapace length of about 3½ inches (90 mm.). A male of corresponding total length has a carapace nearly 4 inches long (100 mm.). Similarly, a female with a carapace 4 inches long has an abdomen about 7⅛ inches long. A male with a carapace 4 inches long has an abdomen 6 inches long. (See Fig. 1 and Fig. 2). The important question remains then as to whether males and females of the same total length are of the same age. A sexual difference exists also in length-weight relationships in the Bermuda spiny lobster. In the graph (Fig. 3) weight differences between the sexes appear in the total length-weight plotting. The sexual difference is most apparent in the larger size ranges.

A five pound female lobster is about 400 mm. (15¾ inches) long while a five pound male would average 370 mm. long. Similarly, two pound female lobsters are about 285 mm. long (11¼ inches), while two pound male lobsters are about 275 mm. long. A six pound female lobster is about 425 mm. long and a six pound male is about 390 mm. long.

The maximum lengths obtained, however, are approximately the same for the two sexes. The largest female examined was 437 mm. long and only three



ig. 2. Carapace length—abdomen length relationship of spiny lobsters in Bermuda, by sexes.

males over that length were observed. The large female weighed 6 pounds and 12 ounces. A male of the same weight was 404 mm. long. The males have a greater carapace girth than the females. In large male individuals the carapace appears inflated. However, this greater visceral mass in large individuals does not completely explain the difference in length-weight relationships as it is evident to some extent in even one pound individuals. Males of this weight average 215 mm. long while the females average 225 mm. It appears that for a given total length male spiny lobsters are heavier, and that this is due in part to a greater weight of the visceral portion.

A length-weight curve based on both sexes has been given by Smith (1948) for Caribbean lobsters. Bermuda results are similar. However, such graphing is probably a composite curve in view of the foregoing results from graphing the sexes independently.

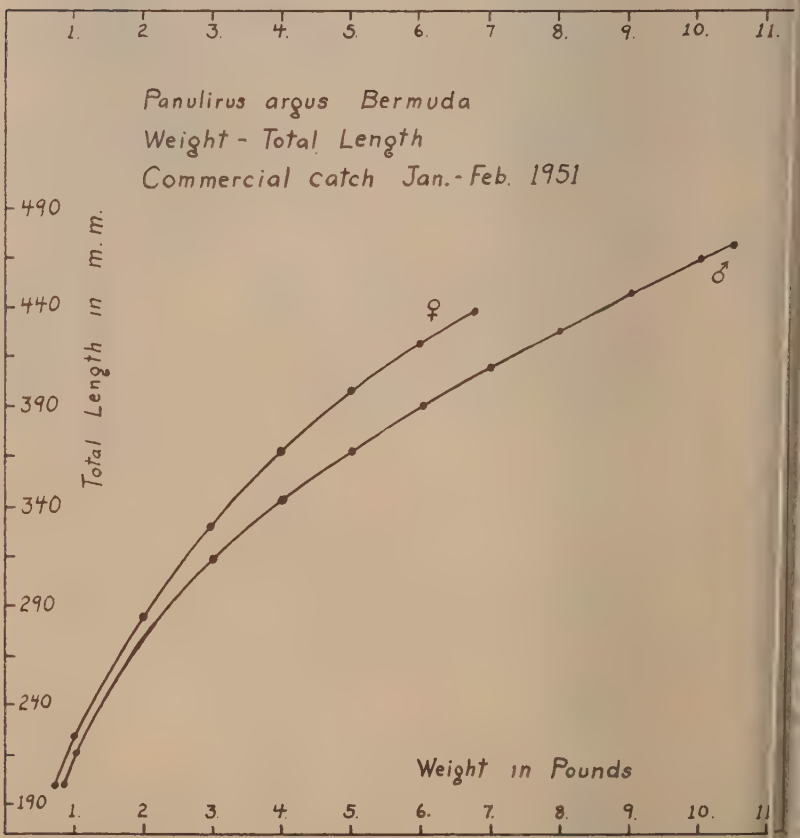
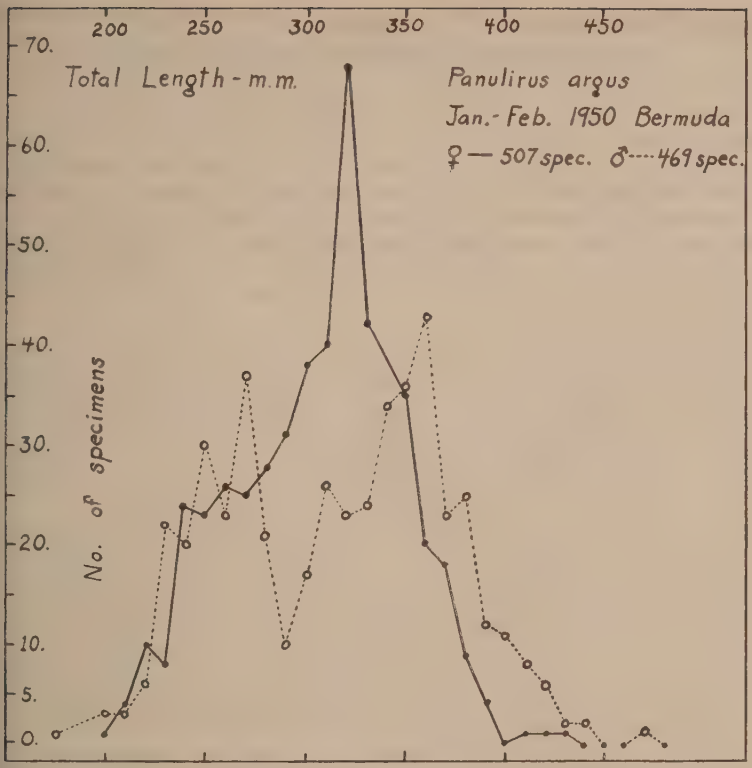


Fig. 3. Weight—total length relationship of spiny lobsters in Bermuda, by sexes.



ig. 4. Length frequency of spiny lobsters in Bermuda, by sexes.

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Some Observations of the Breeding and Migration of th Bermuda Spiny Lobster, Panulirus argus *

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Introduction

This paper deals primarily with certain aspects of the investigations betwe March and September of 1951. Research on the spiny lobster (*Panulirus argu* in Bermuda was started in 1949. Then and in 1950, except for short perio during the fall and winter, lobster research, conducted by Dr. E. P. Creas was confined mainly to summer work. In March, 1951, lobster investigatio were put on a full time basis, aided by a grant from the Bermuda Governme

Methods

Much of the information was obtained from lobsters taken in traps or "po operated by the Biological Station. These were similar in design and constr tion to those used by the great majority of Bermuda fishermen. Since lobs fishing is not permitted in Bermuda from April 1 to August 31, little inf mation has been obtained this year from commercial catches, although t source will be utilized in the appropriate season.

The trap is of 1½ inch galvanized iron wire mesh stretched over a fra work of unsmoothed spicewood sticks bound together with short lengths wire. The trap is rectangular in section and ordinarily 18 inches high (altho "2-foot pots" are in use by some fishermen), 36 inches wide, and about inches at its greatest length. The shape from above is somewhat on the or of a greatly thickened chevron, that is, one end pointed and the other V-shaped or indented. A wire funnel is built into the concave end leading i the trap. The frame of spicewood, favored because of its durability and wei usually varies slightly in pattern according to individual preference. overall shape and design seldom varies.

The traps are baited with fish and, if set in shallow water down to a 30 feet, are unbuoyed. The set is usually made in a sandy hole on rocky bot and left for several days. The trap is retrieved by casting a small grapnel which the local fishermen are very skillful. If in deep water, the trap is buce with rope and corks.

Since March, 1951, from 15 to 30 traps have been maintained in var locations depending on weather and loss through theft. The traps were vis after two and not more than six nights of fishing if weather permitted.

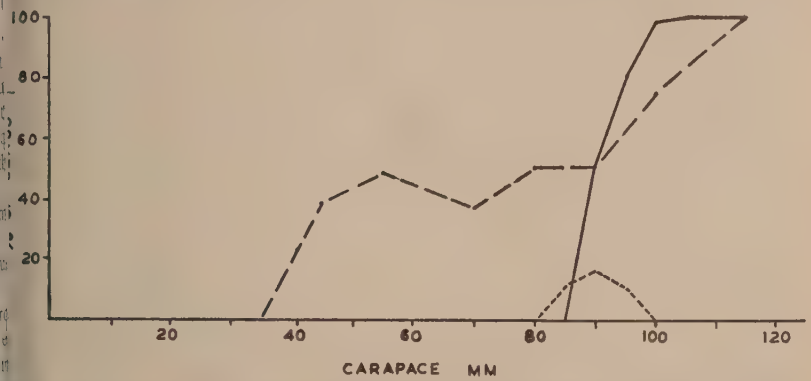
Trapping efforts were concentrated in a two-mile section of the Ber Plateau which included North Rock, Ferry Reach, Castle Harbor, and Nonsuch Area of the South Shore. All locality references to the North R North Shore, and the South Shore are within this section.

Breeding

The great majority of the population apparently did not begin to mate mid-April, although a single sperm-bearing female was found late in M Mating lasted for about one month for by the middle of May most of mature females were found to be carrying the sperm masses. Sexual mat in the females is attained sometime after the carapace length reaches abo mm, as may be seen from Figure 1, although Creaser (1950) has rep a female of 85 mm with eggs. This is to be compared with a length of a 45 mm (Smith 1951) for the Florida spiny lobster (see Figure 1) wh

*Contribution No. 180 from the Bermuda Biological Station.

reeding starts in March. This agrees with Bradstock (1950) in that *Jasus alandii* was found to become sexually mature at a considerably smaller size n regions of warmer water. A similar situation was reported by Templeman 1936) for the northern lobster, *Homarus*. The dotted line in Figure 1 rep- esents females carrying sperm masses only and showing no signs of carrying, r having carried, eggs. Since the sample was taken at the height of the egg- earing season these were possibly females which had very recently become exually mature. An alternate consideration is that these females had not yet ecome sexually mature but had the sperm masses deposited on them by males hich had matured at a smaller size than those which ordinarily mate with ne larger females.



gure 1. Size at maturity of spiny lobsters —— Females with eggs or signs of having carried eggs; - - - - - females with sperm only; — — — Florida females with eggs (from Smith 1951). For convenience the graph is terminated at 120 mm.

Mating has not yet been observed in the Bermuda lobster. It is to be in- rred, however, that with this animal, as with the northern lobster (Templeman 34), mating individuals are approximately the same size, for female lobsters ways bore sperm masses in proportion to their size. It is not known with rtainty whether moulting is a necessary prerequisite for the first mating, al- ough it is a strong possibility, judging by other decapods, such as Homarus ee Templeman 1934). Moulting is not a necessary preliminary to subsequent atings during the same season, however, for females have been found with shly deposited sperm masses, bearing eggs in all stages of development, th remnants of the old used sperm mass underneath the later deposit. By ne most of the females were carrying eggs on the swimmerets.

Egg laying of the Bermuda lobster was observed in three instances in the oratory. As has been previously reported (Crawford and de Smidt, 1922; hith, 1948; Lewis, 1951), the female scratched the sperm mass repeatedly th the small chelae on the fifth legs. This activity has been observed in the oratory on a number of occasions and seems to precede egg laying by a day two. The scratching removes the hardened gray or blackish surface of the rm mass and lays bare the somewhat softer creamy-white interior in which spermatoza are inbedded, as shown by microscopic examination. Each fifth scratches the appropriate lobe of the sperm mass, for if one fifth leg is noved the scratching is unilateral. During the egg laying the female lies partly its back, at an angle of about 50 or 60° from the bottom, propped up by

the reflexed antennae. Most of the weight, apparently, is borne by the flexed abdomen. The legs, including the fifth pair, wave about freely in the water. The fan-like telson and uropoda extend ventrally just beyond the openings of the oviducts while the leaf-like exopoda of the swimmerets seal in the sides of the curled abdomen, effectively forming an egg-laying chamber and prohibiting the escape of the eggs prior to attachment. Imperfections or absence of the uropoda or pleopoda may allow large numbers of eggs to be lost during egg laying. As the eggs are laid and carried down, apparently by gravity, a constant waving motion is kept up by the endopoda of the swimmerets. The eggs adhere to the hairs on these endopoda. Upon completion of the egg laying the female retains the posture for a few minutes longer while continuing to wave the egg bearing endopoda. As the initiation of the actual laying behavior has not been observed, the time required for the completion of the act is not known. However, judging from the rapidity of egg deposition, it probably could not require more than a half hour and possibly much less. This procedure differs somewhat from the egg laying posture reported by Crawford and deSmidt (1922) for the Florida lobster, in which the eggs are layed in the usual resting position.

Fertilization must occur between the moments of laying and of attachment. It is possible that the enclosure formed in the process of egg laying serves also to insure fertilization. After egg laying is completed the surface of the sperm mass is eroded and pitted as if from solution or by chemical action. Smith (1951) suggested enzymic action as being responsible. This eroded appearance is distinct from that of the scratches and gouges left by the fifth legs before laying. It would thus appear that some substance is emitted with the eggs that releases the spermatozoa from the mass, and that the scratching by the fifth legs is not an act of fertilization but a preparation for the event. A concentrated solution of spermatozoa is produced within the laying chamber, through which the eggs must pass for attachment. It is of interest that the whitish surface of the used sperm mass soon assumes the hardened blackish or grayish aspect ---characteristic of the original unused mass, although it retains its eroded sculpture. The female may spend the day or so following egg laying picking off most of the used sperm mass remnant.

The eggs hatch in about a month, as indicated by evidence obtained from females kept in the laboratory and by the appearance of many shed females in the first two weeks of July. These shed females can be distinguished by the discolored hairs on the endopoda, by the somewhat warped shape of the endopoda of the swimmerets, which look as though they still surrounded a mass of eggs, and by remnants of the first sperm mass which frequently remains beneath the second. In most cases females laid eggs for a second time within a week after shedding the first eggs. By mid-July a majority of the females were carrying eggs for the second time. The data on females are not yet complete enough to make an accurate timetable of all breeding events, although further investigation will probably provide this. The time of mating and egg laying will undoubtedly vary from year to year with environmental condtions.

Distribution and Migration

There seems to be a definite relation between depth and/or distance from shore and the size of the individuals encountered. Figure 2 shows length-frequencies of samples taken from three localities. The solid line represents a sample from the South Shore at depths ranging from 12 to 240 feet. The bottom is extremely rocky and the shore precipitous, with relatively little water shallower than 10 feet. The dashed line reperesents specimens from the Re-

nd adjacent portions of Castle Harbor at depths of about 8 to 17 feet. The ottom is sandy or grassy and is dotted and ringed with small coral and low edges. Collections were made here, as with the above sample, with standard obster traps. These results are substantiated by two previous summers' records nd by a small sample taken in January, 1951. The dotted line in Figure 2 epresents a sample taken partly in small traps but mostly by hand collecting n the very shallow water (usually less than 4 ft.) close to shore. Thus it is een that the smallest lobsters were found in the shallowest water near shore vhile lobsters of larger size were found in deeper water further from shore. The differences between the smallest and intermediate size ranges shown in Figure 2 can not be explained on the basis of collecting technique alone, for ne 40 to 50 mm class is still large enough to be taken by standard traps and ; nevertheless completely absent from the next sample containing intermediate ize lobsters. The smallest lobsters were readily taken in shallow water using ne same bait as the large traps. In addition to trap data, investigations with iving helmet have shown, as yet, no small lobsters in deeper water. Preliminary bervations in Harrington Sound bear out the above distribution pattern. None f the small and intermediate sizes have yet been taken at the North Reef ations although the data are rather scanty at present. Further research will now whether this situation is typical of Bermuda and of other seasons.

Migrations associated with breeding are well known in spiny lobsters and ave been referred to by a number of workers. An outward migration of bsters from Harrington Sound was intercepted in a later part of June. Of 64 ecimens examined only four were males. All the females were in breeding ondition, having eggs and/or sperm. This coincided with a considerable in- ease in the catch per unit of effort on the South Shore (Fig. 3) and a rise the female to male ratio (Table 1). A similar change in sex ratio was found Crawford and deSmidt (1922) in Florida.

The unit of effort for quantitative studies was established on the basis of e number of lobsters caught per trap-night of fishing. Although there are rtain limitations to this unit, such that one trap fishing for six nights is

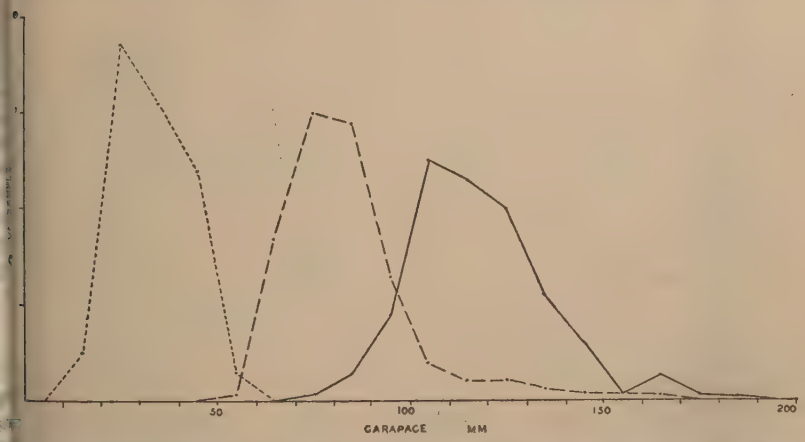


Figure 2. Length—frequencies of spiny lobsters taken in three localities. —— lobsters collected from the South Shore, 269 spec; — — — Ferry Reach, 179 spec - - - - - Ferry Reach and Whalebone Bay, 150 spec. All lobsters taken in summer, 1951.

not strictly comparable to six traps for one, it is felt that this standard is o that can be conveniently used for purposes within its limitations. Bradsto (1950) used a similar unit of effort.

The catch increase on the South Shore was more than could be account for by an influx of females only, so some males must have been coming into t South Shore area as well (see Table 1). There was in addition, a noticeab

TABLE 1. South Shore. Percentage of females compared to catch in lobsters per trap night.

Date (1951)	Percent females	L/NT
June 1 —15	41	0.14
June 15—30	45	0.24
July 1 —15	56	0.49
Aug. 1 —15	53	0.31
Aug. 15—31	56	0.21

lack of breeding size (90 mm or more) females on the North Shore and in t Lagoon. There is thus a migration of breeding females in those portions of t South Shore investigated, if not to the entire periphery of the Bermuda Platea It should be pointed out that this is not necessarily a migration to deep wat

Figure 3. Bimonthly catch of spiny lobsters per trap night, on South Shore. Gap repres two weeks of bad weather. Total of 1404 trap nights with a minimum of 5 t running concurrently.

or some of the South Shore trapping area is shallower (usually less than 30 eet) than many parts of the lagoon and sounds. There is tentative evidence ointing to an inward migration, or at least a lack of females, from deeper vaters of the shelf and of the slopes since traps in these depths (on the South Shore) have caught only males. This breeding migration to the South Shore pparently follows the first mating and precedes the hatching of eggs.

A migration of considerable magnitude has been cited by a reputable local isherman who witnessed the event in the fall "several years ago." He could ive no information as to direction of movement. This might be comparable o a migration seen by C. M. Breder, Jr., at Bimini in October, 1950 (personal ommunication). In this case the lobsters were coming in from deeper water in reat numbers. This lasted only a day.

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A Preliminary Report on the Biology and Economics of the Spiny Lobster in Puerto Rico

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HE SPINY LOBSTER, *Panulirus argus* (Latreille), is an important item in the cal fish markets of Puerto Rico and is greatly in demand wherever taken. ie most important method of taking these animals in Puerto Rico is by the e of wire traps supported by a framework of wood, ordinarily mangrove ood. These traps are of the same type used to take fish and are approximately feet by 3 feet by 2 feet in size with an opening on one of the short sides. me lobsters are taken with spears, but these are not included in the data of is report. During the past year the collection of data was begun to determine e extent of this fishery and to obtain notes on the biology of this species. is represents a preliminary report on this work now being carried on.

The Division of the Fish and Wildlife Service of the Department of Agriture and Commerce of Puerto Rico, under the direction of Mr. Felix go, conducted a contact survey of the local fishermen as to their catch of th fish and lobsters. There were 213 fishermen who reported a catch of sters, some only a few pounds which were incidental to their catch of fish. e results of this survey indicated a catch of 466,800 pounds of lobster ually. This represents a catch of approximately 200,000 lobsters. The value

of this catch to the fishermen varied from 15 to 25 cents per pound with average of about 18 cents per pound. This represents a total value of ne $100,000 per year to the fishermen. The market price to the consumer avera 25 cents per pound. These data probably represent minimum numbers and probable that the total annual catch of lobsters in Puerto Rico is much hig

Working with the market catch of lobsters at various fishing centers, have been collected as to the size, sex, and reproductive state of the ani taken for market. It has been noted that the length-weight ratio varies extren among the average catch. For example, 2 pound lobsters may vary from inches to 12½ inches in total length, and 3 pound lobsters may vary f 12½ to 14¼ inches.

The average total length of the market lobsters examined was 12.02 inc The average for the females was 11.96 inches and for the males 13.01 in in total length. The average for the Florida lobsters, as given by Dawson Idyll (1951), was 9.5 inches for the females and 10.5 inches for the m The average male lobsters in the local market catch were also heavier the females, the females averaging 2.11 pounds and the males 3.01 pou The size group which occurred at the greatest frequency for the females 20 per cent at the 1½ pound size. For the males, the greatest frequency 17 per cent for the 2¼ pound size. In the Florida lobsters the greatest quency was at 20 per cent for the 1¼ pound size for the females, and 22 cent for the 1½ pound size for the males.

Sex ratio data are not available for the entire year at this time. Howe some data are available for the months of September and October. Du September, 1951, the market catch examined was composed of 43 per males and 57 per cent females. In October the females were also more n erous, 37 per cent males and 63 per cent females. For these same mo the average Florida ratios given for September were 54.5 per cent males 45.5 per cent females, and for October 53.6 per cent males and 46.4 per females. With only these data, no significance can be placed on the gre percentage of females in the local catch.

Even though there is a local law which states, "it is prohibited to ki destroy, or to possess or sell female lobsters with eggs attached during month of the year," there have been female lobsters with eggs observe the market during all months. Definite data are again available for only months as to the percentages of market females with eggs and spermatoph During the month of September of the female lobsters observed at one m center, 54 per cent were carrying spermatophores and 22 per cent had During the month of October, at this same center, 30 per cent had sperm phores and 18 per cent were carrying eggs. In the records of the Florida lob observed by Dawson and Idyll for these same months, 0.9 per cent had spe tophores and zero per cent had eggs during September, and for Octobe per cent had spermatophores and 0.6 per cent were carrying eggs. This gests a much more extensive breeding period here than in the Florida w

These observations on the spiny lobster in Puerto Rico are being cont in order to complete the picture for the entire year.

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Growth and Mortality Rates in Sibling and Unrelated Oyster Populations

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Abstract

rowth characteristics of three different populations of oysters grown near ensacola, Florida, present some unusual features. The populations described ere of the same age and exposed to similar hydrographic conditions for a eriod of thirteen months. These populations may be described as follows:

Wild oysters resulting from natural set on shell cultch during a 12-hour eriod; had unlimited supply of water; oysters were crowded; remained on ell cultch throughout the year; kept free from predators but not otherwise andled or cultured.

Cultivated oysters resulting from natural set on flat artificial cultch during a 2-hour period; oysters cleaned regularly and separated from sub-stratum ithin first two months so that they grew as "singles"; unlimited water supply above group.

Sibling oysters growing on flat artificial cultch throughout the year; had a stricted but not necessarily inadequate water supply; oysters derived from a ngle fertilization; kept free from predators, but not otherwise cleaned; oysters ere not crowded.

Analysis of total mortalities in the three groups gave the following data: ild—67 per cent; Cultivated—33 per cent; Sibling—22 per cent. The sea- nal occurence of mortality was, however, essentially similar in the three oups. Approximately 70 per cent of total mortality in each group occurred uring first four months in the summer. This is correlated with high tempera- re and salinities and not with age of oysters as shown by fact that similar stribution of seasonal mortality occurs in older oysters in same environment. somewhat higher mortality during first months of growth of the wild oysters attributed to crowding.

Analysis of seasonal and total increments in average linear growth of the ree groups showed the populations were remarkably similar. Data were as llows for final average length at age of 13 months: Wild—52.6 mm., Cul- ated—59.3 mm. and Sibling—63.7 mm. However, the range of sizes in e three groups was quite different. Wild oysters varied most and showed e greatest length—from 34 to 95 mm., Cultivated—32 to 70 mm. and Sib- g—48 to 86 mm.

Graphs illustrating curves of distribution of population sizes show a striking ference in the populations. These may be summarzed as follows:

Sibling oysters showed reasonably normal distribution curve, although tails the curve were cut short and there was a concentration of the population the average size. Wild oysters showed a curve with marked shift to the aller sizes although total length attained was greater than in the other two oups. Cultivated oysters showed peculiar frequency distribution in which jority of oysters attained maximum size length. These differences can be plained only on the basis of a combination of both hereditary and environ- ntal factors which influence growth patterns.

Hexamitiasis of Ostrea edulis L. and Crassostrea virginica (Gmelin)

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S. H. Hopkins, *Department of Biology, A & M College of Texas*

*Abstract

Certain types of recurring mortalities have been observed for years in oysters of Holland (*Ostrea edulis*). Oysters shipped as seed from France are often referred to as "weak" because subsequent to transplanting to Dutch waters considerable mortalities are expected. Also a disease known in Holland as the "pit disease" often takes heavy toll of oysters held for market in temperature controlled basins during the winter. In an effort to learn more about the cause of death in these cases oysters have been sectioned for histological study in the hope that if an organism is the etiological agent of the mortalities it could be detected microscopically.

Such an organism has been observed and studied. In one group of live oysters of French origin three out of eight sectioned were found to be infected by a species of the flagellate genus Hexamitus. In two of these the infections had progressed to the point of producing obvious histologic damage. In another group of six moribund oysters from a holding basin at Bergen op Zoom, all were heavily infected by the parasites. Other normal oysters failed to show infection, or contained a few flagellates only.

Hexamitus is a genus at present known to infect trout and other fish, both in Europe and America, and also occurs in insects. A condition known as "pin head disease" is caused in trout and has been reported on by Moore and Davis. Although the trout disease is known in nature, it is predominantly a hatchery disease and the pathological effect on the host seems to be in proportion to the severity of handling procedures in shipment. It may be significant that handling of oysters also seems to increase liability to development of Hexamitiasis. As for the oyster, the fact of flagellate infection has been long known. Certes reported finding Hexamitus and is apparently the first to do so. Orton, while studying mortalities of oysters in England found flagellates in sick oysters (hockleys). He called them Bodo, obviously a misnomer since he figures intracellular stages of Hexamitus but failed to recognize them as such. In America the credit for original discovery of Hexamitus in oysters belongs to Dr. L. R. Richardson, who while investigating mortalties of Malpecque Bay oysters in Canada, found the parasites and reported his findings. His report was mimeographed but not published; a copy was presented to the authors by Dr. R. R. Logie. In a conversation with the senior author Dr. Richardson stated that he believed that the flagellates were the cause of the Malpecque Bay mortalities reported by Needler and Logie so it is certain that he appreciated the possible pathological role of Hexamitus.

Morphologically Hexamitus of oysters is similar to but quite distinct from *H. salmonis* (Moore) of trout. The trophozoite has eight flagellae of which two are trailing. The double nucleus is quite compact and in sectioned material appears usually as a single mass at the anterior end. The axostyles are unique in being curved and spread wide apart, and in the tissues of the oyster they appear very much like prongs of a closed safety pin. Cysts are spherical and

* Published in the Bulletin of Marine Science of the Gulf and Caribbean.

have two or four nuclei. Intracellular stages (in leucocytes) are common in oyster tissues.

In the oyster infection is primarily of the blood sinuses and arteries. They also penetrate connective tissues surrounding the tubules of the digestive gland. Masses of the trophozoites may be sufficient to produce occulsion of vessels, and large visceral abcesses result from destruction of connective tissue. Leucocytes are attacked by the parasites which become intracellular. Most of the details of the cycle are unknown.

A few oysters infected by Hexamitus have been found in Barataria Bay, La., but the disease is apparently not common on the Gulf Coast. Present data indicate that the parasites are acclimated to low temperatures (below 5° C) but the upper limits are not known. It is probable that Gulf Coast temperatures are above the optimum, but that may not be true of the east coast of the United States.

WEDNESDAY, NOVEMBER 14

Chairman—CLARENCE P. IDYLL, Research Associate, Marine Laboratory, University of Miami

How Can Sales of Southern Fish Be Improved in Northern Markets?

FRANK W. WILKISSON

President Frank W. Wilkisson, Inc., Fulton Fish Market, New York, N. Y.

FROM A WHOLESALER'S POINT OF VIEW and experience, the prime factors i building up sales in seafood are quality, honest weight, uniformly graded an packed merchandise and a steady production with a fair price. The former ca be controlled, but the latter regarding production is subject to causes beyon the powers of man. We can take these items one at a time and point out wh they are necessary to provide a healthy market. As we all know, from ou own domestic experiences, palatable seafood makes people take second helping It can only be palatable if it is of good quality. Poor quality has to be doctore up with sauces and dressings which destroy the delicate flavor of seafood ar are usually so strong that they upset the digestive system of all those who t them and then the seafood is blamed. Which in truth is proper, but wh suffers? The industry does. This is mentioned because so many short-sighte fishermen and packers take the attitude that someone will buy their produ regardless of its condition. In other words they feel that there is a market f anything. This is true when supplies are short but does it boost sales? If an thing, it hurts future sales because someone with good trade may get one these poor packages and have it dumped in his lap by the consumers. T retailer is then finished as far as that variety goes and complains to the deal The dealer is skeptical the next time a packer tries to sell him again. He m take a chance on a few, when he should be buying more than he did the fi time to fill the demand he created by distributing excellent quality merchandi

The start of quality is the fisherman's job. He has to take the proper amou of ice with him to chill the fresh caught fish. He should also pack the fi instead of letting it lie on the deck. The greatest amount of deterioration tak place while the body heat in still in the fish. The next step is to gut the f as soon as possible after being caught and to do a thorough job of cleani out the fish. We sometimes receive "gutted" fish with half the entrails left The packer can inspect the catch and then see that it is properly packed new boxes with plenty of ice for shipment to our Northern Markets.

Another important thing is weight. Some producers and packers are habit offenders with short weight. They completely forget that seafood shrinks certain percentage when packed fresh. To offset this, extra weight should added. Some also feel that a fish or two won't be missed. Our greatest trouble short weight in Southern packages. It has reached a point where it is diffic to sell a box or a barrel of fish as a package and not by weight. One m

ealize that a five or seven pound shortage even at twenty cents per pound mounts to an additional cost from one to one and a half dollars per box to he retailer. He naturally has to pass this extra cost to the ultimate consumer, vho will not be too pleased at this increase in his food expense. Another hing noticed is the non-uniformity of the various packages as far as fish sizes o. Many varieties are packed from a half pound to three or more pounds which nakes it hard for a distributor to sell. They should be properly culled and raded small, medium and large. This would help the dealer or distributor find he proper market for the merchandise. Some markets can use large quantities f certain size fish whereas if they are received mixed the dealer sometimes has o pick his size and then reship the remainder to some commission house to sell or his account. This is a very unprofitable set up and forces a dealer or distributor to curtail his buying quantities of that particular variety, because of he amount of work involved and the gamble on the possible resulting profit.

Stories are heard of price contracts being made with the fishermen at the eginning of a season when certain varities are fairly scarce. Naturally the rice is usually high, too high for comfort. The dealer is wary and only buys rom the packer a part of what he could really use if the price was reasonable. The fisherman, with a good price guaranteed, sets forth and usually over produces, overloads the packer who is forced to ship on consignment. This usually luts the various markets and everyone gets frightened and steers clear of that ariety because of its extreme drop in price. The packer then wants to reduce is contract price to the fisherman who gets angry and goes on a strike. There eing no production for awhile, that variety is off the market and consequently emoved from the minds of the dealers who wish they had never seen this articular fish. When it is produced again the cycle returns. Spanish mackerel, nullet and king mackerel are the types that are produced heaviest and they are he biggest headaches as far as our Northern marketing is concerned.

It has reached a point in New York that when we receive a call from a acker we can tell what quality, what cull and how short the packages will be hen he tells up the point of production. We have tried many times in the ast to impress them with the facts stated but they still take the attitude that f you don't want it someone else does." Again that may be true, but will it onsume the additional production he could no doubt bring in? Will it remove he glut period and create a steady market during that time which would give im a small profit instead of a large loss? Will it enlarge the consumer demand? lthough it is only one man's opinion, the writer says no. In fact it may be aid that the current demand will even fall off, because of the increased quality ood products now competing for the consumer dollar, unless we in the industry ake up and get on the quality band wagon.

In conclusion, the writer thinks that such a representative group could take he lead in promoting a program to improve the quality and grading of the shing products produced in the states or countries they represent.

The Development of the Brownsville Shrimp Industry

W. L. Hardee, *Hardee Fish Co., Brownsville, Texas*

This paper will describe the phenomenal change that has taken place in the hrimping industry in the lower gulf area from 1930 to the present time. With he closing of the Bay area on the lower Texas Coast in 1930, the fleet of

small shrimping boats operating from Port Isabel turned their efforts solel to fishing because restrictions placed on bay shrimping made it impossible t otherwise secure a livelihood. For some time it looked as if fishing of any natur on a commercial basis would become extinct in this area, as boats were smal and the nets and gear being handled by hand made it impossible to fish i deeper waters.

In 1935 there were few radical changes in commercial fishing in this area Both Brownsville and Port Isabel had become deep water ports and, as such were growing in importance. The fleet of small fishing boats meanwhile wer somehow managing to exist. During favorable weather they were venturin outside of the jetties to fish their hand-operated rigs, running for harbor a the first sign of bad weather. For a short time in the spring and fall, whil calm waters existed, these boats were bringing to port a small amount of whit shrimp. It was during this time that the first catches of Brazilian or groove shrimp were brought to port. A trial shipment of these shrimp was shippe fresh to a Midwestern market and was immediately rejected as being unsaleabl and unusable by the buyers at the wholesale level.

Seasonal productions of white shrimp continued in this area for the next te years. Slow changes gradually took place as larger boats with better equipmen were warranted by a better market and increased production. Catches wer becoming larger and were being frozen for easier handling and transportatio in the sales end of business. This tended to give stability to the production en of the industry, which, in turn, encouraged individuals and firms to increas their investments in boats and equipments. With these improvements the boa were able to venture further away from port into deeper waters and practicall all of their production was white shrimp.

In early spring, 1947, several out-of-state firms sent boats to Brownsvill to help develop the shrimp industry. Animosity became apparent betwee Texas dealers and out-of-state interests, resulting in the non-resident boa actually being legislated out of the state.

In the late fall of 1947 it was discovered that huge beds of grooved shrim were off shore in depths of twenty fathoms or more. It was thought that the markets could be educated to accept the reddish brown color as beir natural, these beds would afford an inexhaustible supply for the shrimpir industry. There was no doubt that the quality and edibility of the groove shrimp was every bit as good as those of the whites. To this end, firms an individuals engaged in the production and marketing of shrimp started the program of education. Shipments were made to market centers as much as 1 cents a pound under the white shrimp price. Distributors, chain stores ar jobbers were urged to take the Brazilian shrimp and to assure their custome that the reddish-brown color was natural and in no way was there any conne tion between the color and age or state of freshness of the shrimp. The Fi and Wildlife Service issued a special market development Bulletin No. 18 wherein they assured the reader that the Brazilian shrimp was as good as th common white species. By late 1948 Brizilian market acceptance was growi more favorable.

In 1948 production of shrimp in this area increased rapidly. Shrimp trawle began working out of the Brownsville port. Facilities for boats were very fe Early in 1949, 47 out-of-state boats returned to Brownsville, this time dete mined to stay. Through legal procedure, very costly to both factions, it w determined by courts that out of state boats could legally operate from Tex

orts. The knowledge that out-of-state boats could legally fish from Texas ports rought many fleets from various areas.

With this influx of boats locating mostly in the Port of Brownsville, this city ddenly awakened to the added wealth that this industry was bringing to this ea. Millions of dollars were spent for more convenient unloading and working cilities, and enlarging freezer and storage capacities.

By this accumulation of men, representing numerous nationalities, there as foreseen a great need for cohesive efforts. Problems common to all were cing them. To achieve this effort and to solve the problems confronting em, the Brownsville Shrimp Association was formed. This Association's embership was made up of the numerous shrimp dealers located here. This w association continually strived for quality control, and always advertised razilian brown shrimp. The remarkable acceptance of this new species of rimp by the trade as a whole is evidence within itself that careful planning d diligent watching of quality will always bring satisfactory returns.

Due to the success of this organization and to the progressiveness of the alers of other sections of the Texas Coast, the need of a coast wide associaon of dealers was felt. By the middle of 1950 the Texas Shrimp Association as formed. Its membership was represented by dealers from all sections of e Texas Coast working together in harmony and for the common good and nprovement of the industry as a whole.

The spectacular success of this organization and the harmonious working toether of its members brought about the forming of yet another association. hich is known as the Shrimp Association of the Americas. This Association an international association and brings together the Mexican Shrimp Dealers ssociation and the Texas Shrimp Association and its membership is open to her shrimp dealers. It is hoped that those engaged in the shrimp business other states of the United States, as well as in Panama and other foreign untries, will form their own dealer's associations and become affiliated with is international organization. The foundations of all of these groups have a mmon cause. Their purpose is that of facing and successfully solving indstry problems through united efforts.

During the latter part of 1950 several of the Brownsville boats, ever seeking w fishing grounds, made trial trips across the Gulf of Mexico to the Camche banks where were discovered yet another species of shrimp in untold antities. This shrimp being pink in color, the first reaction in the markets re that they were spoiled. By vigorous assurace and education, as well as vertising, once again this new species was accepted by the trade and today now one of the favorites of the market.

It has been proven that the entire lower Gulf area from Corpus Christi, xas, to the Yucatan Channel is an enormous shrimp producing area and by ng strict conservation methods, this area will become practically an inhaustible source of supply. This year the shrimp industry has brought ormous prosperity to this area; the most amazing part of all is that no one ilized the possibilities of these vast resources until a cosmopolitan group of n, joined together for the common good of all, with the foresight of veterans, a systematic manner and with a long range plan of conservation, quality ntrol, advertising and distribution, began to explore the possibilities of this a and have at this time only scratched the surface.

Prior to 1948 practically all of the production in this area was of the white cies which was more or less a seasonal proposition, with some seasons good l some bad. Discovery of the off-shore Brazilian species and the increased

catches per boat caused the production of brown shrimp to soon outdistanc the white shrimp production and today 95 per cent of the production of th area is brown shrimp and the shrimp industry has been changed from a fa weather venture to a year-round business.

The following table of shrimp production gives a more concrete picture o the growth of the industry. These figures are the combined Port Isabel an Brownsville production in pounds of headless shrimp tails:

1947	1,750,000 lbs.
1948	4,447,700 lbs.
1949	13,036,840 lbs.
1950	17,189,200 lbs.
1951*	19,056,170 lbs.

*Through Aug. 31, 1951, 8 months.

The general growth and progressiveness of the shrimp industry as such, r flects the agressive willingness of the individuals therein. The change has com about from a small seasonal business to a year round multi-million dollar in dustry. The men that have made it possible for a trawler to profitably see its fishing grounds five hundred miles from port are the men who will continu to show the way in the future.

Breaded Shrimp

L. W. Strasburger, *Vice-president, Envoldsen Shrimp Co., New Orleans, L*

Abstract

The commercial breading of shrimp began in a small way but soon mus roomed as rapidly expanded markets gave new and additional outlets. Toda breading uses a large percentage of the small and medium size headless shrim which formerly acted as a depressant factor on the shrimp economy, but whi today are actually a bouyant factor. They are a tremendous help in marketi the production from the Atlantic Seaboard and the Gulf shrimping areas.

The breaded shrimp industry has a large number of ethical producers w have been striving constantly to place on the market a product which is cle is produced in a sanitary manner, and is free from decomposition and defec However, the immediate popularity of breaded shrimp with the Americ public has been felt to be a bonanza by many, who desire only to reap qui large profits, and who have been heedless of the type of product they int duced into the trade channels. The result has been injury, not only to the selves but to the industry as a whole. The new industry is jeopardized these practices. Its leaders must, therefore, take on the obligation of "clean house" in the industry, unless they wish to have it done by those who, in process might easily wreck their economy.

From the data presented at the Shrimp Clinic of the National Fishe Institute at the Boston Meeting in April, 1951, and the writer's own obser tions and experience, it is felt to be imperative that the breaded shrimp p ducers bend every effort to place on the market a product which is free fr decomposition, bacteriological, insect and rodent contamination; a product w a minimum of breading material; which is full weight as declared on the pa age; and is of a reasonable size variation.

HURSDAY, NOVEMBER 15

hairman—RICHARD T. WHITELEATHER, Assistant Chief, Branch of Commercial Fisheries, Fish & Wildlife Service, Washington, D.C.

Studies on Black Spotted Shrimp*

. A. FIEGER, *Department of Agricultural Chemistry and Biochemistry, Louisiana Agricultural Experiment Station, Louisiana State University, Baton Rouge, Louisiana.*

N THE PAST DECADE shrimp production has increased considerably through the se of larger boats which were able to extend the off-shore fishing areas. This ct has resulted in longer storage on the trawlers and a longer period of time etween catching the shrimp and their ultimate consumption. New species of rimp, furthermore, which are more susceptible to deterioration in refrigerated orage, are entering commercial channels. Because of these conditions, probms of proper refrigerated storage have arisen; one of the most important these has been designated as black spot of shrimp (Fieger, Colmer & Alford, 950; Fieger 1951).

Black spot is not peculiar to Louisiana-caught shrimp, for Idyll (1951) in recent article described this condition in shrimp caught off the Florda Keys d designated it as black discoloration. L'Ecluse[a] mentioned the seriousss of black spot in shrimp caught in the Gulf of California and transported truck to Los Angeles. From Australia, Empey,[a] Principal Research fficer of the Division of Food Preservation and Transport, reports some bservations and preliminary work on a condition known as "black head" in completely cooked prawns (shrimp). Likewise, Chambionnat (n.d.) of the fficial Chemical Laboratory of Morocco has studied the development of black scoloration of pink shrimp of Morocco, *Parapenaeus membraneus,* Risso or *rapenaeus longirostrus,* Lucas. From these reports it is evident that black ot or black discoloration of shrimp is of world-wide distribution. From rerts received, it appears that black spot is a more serious problem in Morocco d Australia than it is in the United States.

Since black spot or black discoloration has become of international imrtance to the shrimp industry in the past few years, this condition is desbed. Black spots develop in shrimp, both whole and headless, during regerated storage. With headless shrimp, the abdomen or "tail" may have one several black spots or bands, usually at the base of shell segments or across back of tail where shell segments overlap. In general, the discoloration st develops in the membrane which separates the tail flesh from the shell, pecially in that area where the membrane connects together the two ends of erlapping shell segments.

When whole shrmip are stored black spot usually develops first in the

Personal communication to the author.

This research was supported by a grant from the Refrigeration Research Foundation, Colorado Springs, Colorado.

head cavity so that the carapace or "head shell" becomes black. This is followed by discoloration of the antennule and rostrum or "spine" and the uropod or "tail fin." The crawling legs, or periopods, change color first at the joints and this change finally progresses over the entire leg, while the swimming legs or pleopods become black at the tip ends. When the condition becomes severe, the interior of the head becomes a black soft or mushy mass and the carapace becomes flexible instead of retaining its normal stiff consistency. In fully 75 per cent of the black spotted shrimp examined, the chitin or shell, has been punctured or eroded away. Since the edges of the pierced portion are smooth and not jagged it is believed that these holes in the shell result from chemical solution and not from mechanical injury. The liquid which exudes from the shrimp is black and is spoken of by shrimp fishermen as acid, but is in reality alkaline.

What causes this condition to develop? Knowing the cause it is reasonable to ask what can be done to prevent its development. As indicated above, several laboratories have become interested in this problem. A year ago last September J. A. Alford and the writer showed that black spot is not caused by microorganisms and does not result from chemical changes in the shrimp brought about by microbial activity. Rather, it was proved to be caused by an enzyme system which is present in the shrimp tissue. Quite independently at about the same time, the Morocco group under the direction of Chambionnat came to the same conclusion. Their work came to the writer's attention last February.

It has been shown (Fieger, 1951) that air, or more specifically oxygen, is necessary for black spot development, by the following experiments. 1.—Whole shrimp, suspended in water in flasks closed either with a rubber stopper or a cotton plug, did not develop black spots after 125 hours storage in crushed ice. The odor of the shrimp was that of fresh shrimp, the liquid had a slight brown color. 2.—The same set-up as described above was used, but with air bubbling through the suspension of shrimp and water. After 75 hours, several shrimp had developed black spots and after 125 hours 90 per cent of 18 shrimp had black spots on their heads, 70 per cent had them on their tails. The liquid was black and the odor of the shrimp was not quite as good as that of fresh shrimp. 3.—When pure oxygen was bubbled through a set-up similar to that previously described, after 54 hours one shrimp had a black spot and at 125 hours 100 per cent of 18 shrimp had black spots on both sides of their heads and all had black spots on their tails. The liquid was black and the odor was not quite as good as the controls.

These results proved that oxygen was required for black spot development and strongly suggested an oxidative enzyme was also involved. Many of the brown and black pigmentations found in nature, such as black feathers, wool and hair, and the brown color of freckles and sun-tan, the pigmentation of Addison's disease and of malignant tumors are caused by the oxidation of tissue substances to brown or black compounds. These colored substances are called melanin. In marine animals, the black liquid of the ink-sac of the cuttle fish contains tyrosinase (Gessard, 1903). Bhagvat and Richter (1938) found evidence of tyrosinase in the blood of the octopus. Pinhey (1930) has shown that the black discoloration of the spider crab and edible crab is caused by the action of the enzyme tyrosinase present in blood corpuscules upon compounds in its blood. To prove an oxidation enzyme or enzymes cause black spots to develop, the following experiments were performed.

Whole shrimp and headless shrimp were suspended in solutions containi

hydroxyphenylalanine ("dopa"), the containers were packed in ice and air as bubbled through the solution. Within six hours the liquid had turned black nd black spots were well developed on all of the shrimp, in contrast to the 25 hours required to develop spots in the previously described experiments. lso, the shrimp suspended in the dopa solution had more intense or severe ack spots than those suspended in water. Likewise, water-clear extracts of rimp tissue turn black in the presence of dopa and air. Other dihydroxy-henyl derivatives besides dopa, such as catechol, hydroquinone and pyrogallol, e oxidized by shrimp tissue, the former two resulting in red solutions and d spots and the latter black solution and black spots. Of the monohydroxy-henyl derivatives, tyrosine and ortho-and meta-cresols are apparently only ghtly oxidized, while para-cresol is rapidly oxidized by shrimp tissue and rimp extracts. Since both types of hydroxyphenyl dervatives are oxidized the riter has tentatively designated the enzyme as tyrosinase in conformity with e suggestion of Lerner and Fitzpatrick (1950).

The following facts present further evidence that an enzyme is involved. hen shrimp extracts are boiled for one minute over a free flame complete activation results, even in the presence of dihydroxyphenols. The optimum H is 7.0, while a pH of 4.5 or lower prevents spot development. Chemical mpounds which bind or unite with copper (oxidase enzymes are copper pro-ins), such as sodium cyanide, sodium azide, thiourea, cysteine, glutathione d sodium molybdate, completely prevent black spot development.

All the above evidence proves rather conclusively that an oxidase enzyme responsible for black spot or black discoloration. Having shown that an zyme, tyrosinase, is involved naturally raises the question of distribution of e enzyme in the shrimp. It is present in the head, in the fins, legs, and the ell and membrane of the tail. It is not present, however, in the tissue of the l.

In continuing our investigations on this problem Mr. James Friloux, using e Barcroft Warburg manometric apparatus, has obtained evidence indicating marked species difference in the amount of the enzyme tyrosinase present the tail shell. Brown shrimp contains the highest amount, while white shrimp s the smallest quantity of the enzyme. This order of enzyme content checks ll with known incidence of development of black spot in these species in mmercial storage.

Since the black substance formed in the shrimp through the action of tyro-ase is undoubtedly melanin, it is suggested that the terms "black spot," "black coloration" and "black head" be discarded, at least in the scientific litera-re, and in their stead that we use the term melanotic shrimp. The chemical nges which occur would then be known as melanogenesis and the black oration as melanosis.

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Freezing Shrimp At Sea

H. E. CROWTHER, *Chief, Technological Section, Branch of Commercial Fisheries, Fish and Wildlife Service, Washington, D. C.*

ONE OF THE MAJOR PROJECTS in the Fish and Wildlife Service's present technological program is freezing fish at sea. By means of this research work it is hoped to determine whether it is possible to freeze fish in the round at sea and later at a shore plant defrost, fillet, package, and refreeze the fillets and still obtain a high quality product. Such a process, to be practical, must be workable not only from a technological and mechanical viewpoint but it must be economically sound. Experiments now in progress at Boston are providing information which will permit a definite recommendation to the fishing industry on the feasibility of the process.

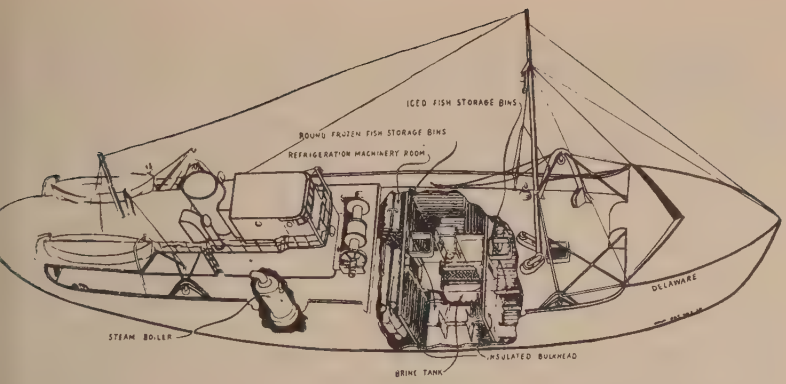
Specifically, the main purpose of this paper is to describe briefly the work being done at Boston and to pass on to those interested in the shrimp industry the information gained thus far in fish freezing work which may be applicable to shrimp.

Present Refrigeration Methods Used on Shrimp Boats

Shrimp boats in the Gulf of Mexico may be divided into two general classes, according to their size and area of operation. The small boats, ranging in lengths from 25 to 55 feet concentrate on the shallow, inshore waters. The larger vessels from 50 to 80 feet in length fish the off-shore waters and can remain at sea for as long as 10 days. Many of the vessels in the 50 to 80 foot class and capable of fishing in any part of the Gulf and are often found in the distant Campeche area.

Crushed ice is practically the only means of refrigeration available to a majority of the shrimp boats. On long trips, such as those to Campeche, ice may be the item which determines the length of the trip. Fishing time on the grounds is limited because provision must be made for the 3 or 4 days required for the voyage to the plant, so fishing must cease when the ice supply reaches a low point. Travel to and from distant fishing grounds is not only costly but involves the chance of loss of the entire catch of shrimp through spoilage if delay occurs. One possibility of extending the length of the trip is to use some form of mechanical refrigeration to retard the melting of the ice or to replace the ice entirely as a refrigerant. Some boats have installed such equipment but they are few in number.

The most recent approach to solving the refrigeration problem is the use of freight boats or mother ships to pick up the shrimp from trawlers on the fishing grounds and freeze the headless shrimp at sea in 5 pound cartons. Several boats of this type are now in operation and apparently are having some



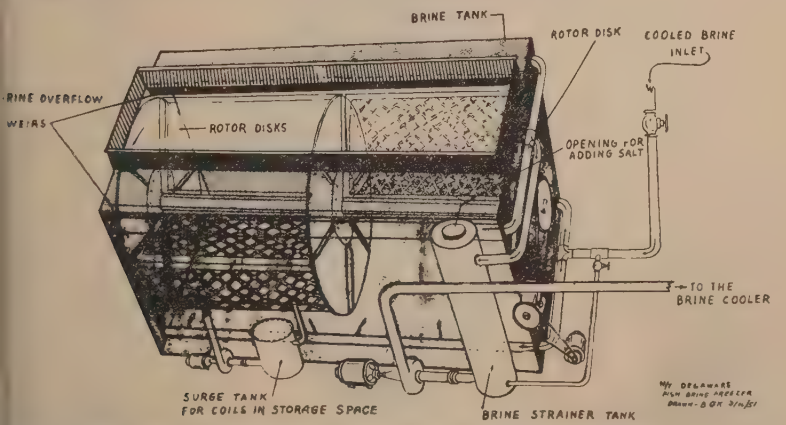
GURE 1—Cut-away view of the *Delaware* showing location of the refrigeration system.

ccess. These boats may also be used to carry ice and other supplies to the rimp fishing boats.

For the majority of shrimp boats now in operation, however, ice appears to the only available means of refrigeration. If some practical low cost method freezing the shrimp at sea on the individual boats could be found it would ve many advantages, such at (1) eliminating black spots; (2) eliminating oilage; (3) permitting continuous fishing until a full load is obtained without pendence on melting ice; and (4) above all, insuring the production of only p quality shrimp. No definite recommendation is made at this time regarding ch refrigeration equipment but perhaps the information obtained from the oston operation will indicate some possibilities which are worthy of investi-tion.

Preliminary Results of Freezing Fish at Sea

The vessel used in the fish freezing work in New England is the modern awler, *Delaware*, which is approximately 148 feet in length and has a capacity r carrying over 300,000 pounds of iced fish. Several years ago it was one of e larger vessels of the commercial fishing fleet of Boston.



URE 2—Brine freezer tank showing rotor and brine circulating equipment.

Today, the outward appearance of the *Delaware* remains the same but a substantial change has been made in the hold of the vessel, as may be seen from the sketch of the *Delaware* showing a cutaway view of the hold (Figure 1). An insulated partition has been placed so as to divide the hold equally. One half of the hold now contains bins for icing fish—identical with the method now used commercially for holding cod, haddock and similar fish in crushed ice. In the other half of the hold a brine freezing tank containing a rotary freezing apparatus (Figure 2) has been installed. The sides and ceiling of this half of the hold have been insulated and lined with refrigerating coils to help convert this entire half of the hold into a storage room for frozen fish.

The fish caught in the otter trawl and landed on the deck of the vessel are immediately placed in the V-shaped wire mesh sections of the rotary freezing apparatus shown in Figure 2. The entire rotating mesh basket containing the fish is submerged in 80% saturated NaCl brine which has been chilled to a temperature of approximately 5° F. Immersion in a liquid, such as brine, provides the most efficient means of removing heat from the fish, or in other words, freezing them. The purpose of the rotating action of the basket is to make certain that the cold brine is in continuous contact with the fish. If a stationary basket were used the floating action of the fish in concentrated brine would cause the fish to pack so closely that the cold brine would not come in contact with the fish in the center. In the rotating basket the fish are continually changing position and the brine must flow around them.

The time required to freeze fish in a brine solution depends on a number of factors. Obviously, the most important of these are the temperature of the brine and the size of the fish. In order to report on some of the preliminary results obtained in Boston a very large haddock, 4 inches in diameter and weighing about 10 pounds, will be taken as a starting point. If the 10-pound haddock is immersed in flowing brine held at 0° F., freezing will progress at the rates shown in Figure 3. It is to be noted that during the first hour one inch of the outer layer of the fish was frozen, while during the second hour only a 7/16-inch layer was frozen. The progress of freezing continues to decrease as the distance from the outer surface increases. During the fourth and fifth

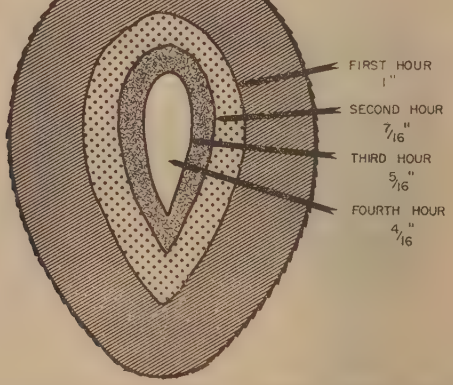


FIGURE 3—Diagram of cross section of Haddock showing freezing rates when held in circulating brine at 0° F.

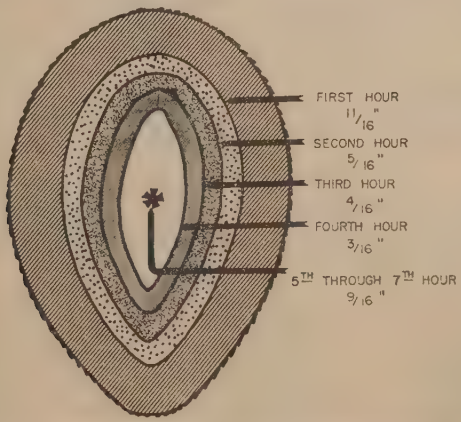
our only a ¼-inch layer was frozen. A small fish 2 inches in diameter should reeze in one hour since the radius, or the distance from the outer layer to ie center, is only 1 inch. Freezing in air would be much slower than freezing brine of the same temperature. Taylor[1] has reported that a fish 4 inches iick would require 8.8 times as long to freeze in air as in brine of the same mperature.

The rates of thawing a fish 4 inches in diameter in circulating water at 65° . is shown in Figure 4. A comparison of the rate of thawing with the rate of eezing will show that at comparable temperatures a fish will freeze faster an it thaws. This is explained by the fact that the frozen layers of fish flesh e better conductors of heat than are thawed layers of equal size.

When freezing in brine is mentioned the first thought which comes to mind penetration of the salt. It seems logical that a concentrated brine would im-ediately impart a strong salty taste throughout any fish flesh with which it mes in contact. At high temperatures the brine does penetrate fast but at w temperatures such as 0° F. even the layer of flesh just beneath the skin es not show any appreciable increase in salt content. Normal haddock flesh nich has not been exposed to brine has a sodium chloride content of about 2 per cent. Haddock frozen in concentrated brine at 5° F. has a sodium loride content of about 0.6 per cent in the ¼-inch layer next to the skin. hen this haddock is thawed in fresh water the salt content drops to 0.4 per nt. This concentration approaches the normal salt content of the fish.

Preliminary Results on Freezing Shrimp in Brine

The results given above are for fish. If shrimp were immersed in the chilled ne what would happen? Very preliminary tests with headless jumbo shrimp calcium chloride brine (40 percent by-weight) at a temperature of -3° F. owed that the shrimp would be completely frozen in 5 minutes. Headless imp approximately 3 inches long ⅝ inches wide and 1 inch thick were zen to a depth of one-eighth of an inch in two minutes; nine-thirty-seconds an inch in 4 minutes; and to the center in 5 minutes. The temperature of the



GURE 4—Diagram of cross section of Haddock showing thawing rates when held in circulating water at 65° F.

1 lor, Harden F., "Refrigeration of Fish," U. S. Bureau of Fisheries Document No. 16 (1927).

shrimp when placed in the brine was approximately 65° F. The results of these very preliminary tests indicate that the shrimp will not stick together on freezing and will be rather easy to handle. Previous freezing tests indicate that if shrimp are to be frozen in brine the heads should be left intact in order to avoid direct contact between exposed flesh and the brine. Freezing shrimp with the heads on has the advantage of permitting the shrimp to be immersed in the freezing solution immediately after capture instead of being held on deck a unfavorably high temperatures until it is convenient to carry out the heading operation.

Refrigeration System

Now that the possibilities of brine freezing of shrimp have been described the next logical question is, what chills the brine. There are two principa

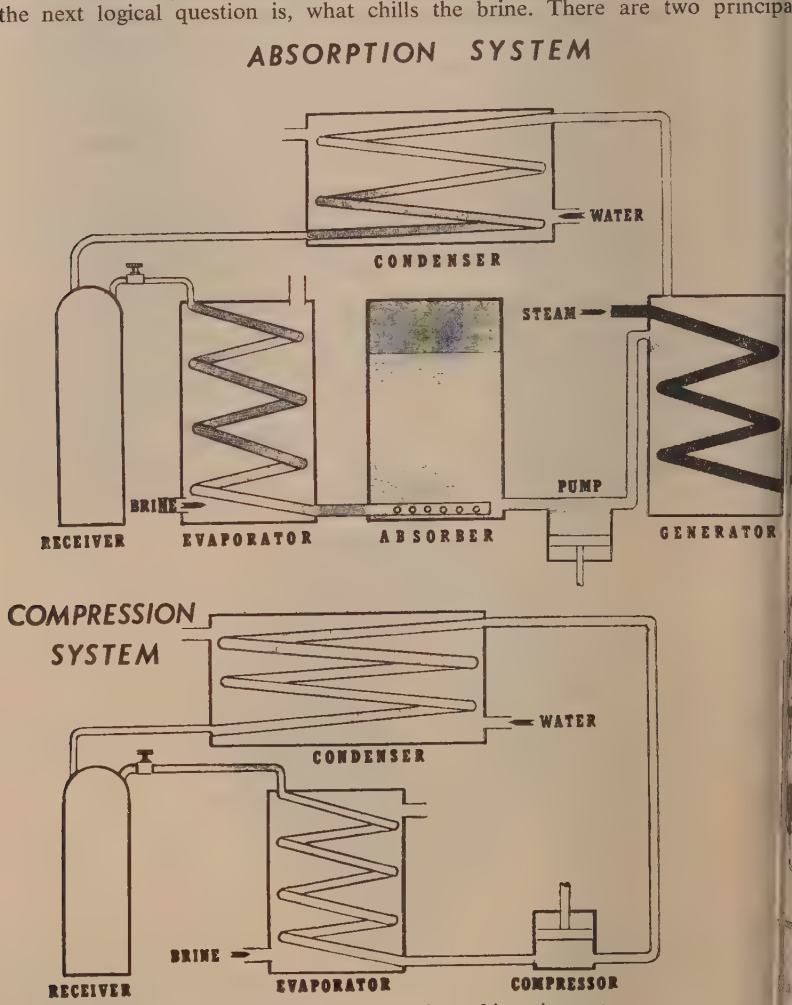


FIGURE 5—Outline of absorption and compression refrigerating systems.

methods of mechanical refrigeration,—the compression system and the absorption system. The compression system is the better known by far and is the more widely used of the two both in commercial and household units—but the absorption system does have certain advantages.

After considering both the favorable and unfavorable features of both systems, the absorption system was chosen for installation on the *Delaware*.

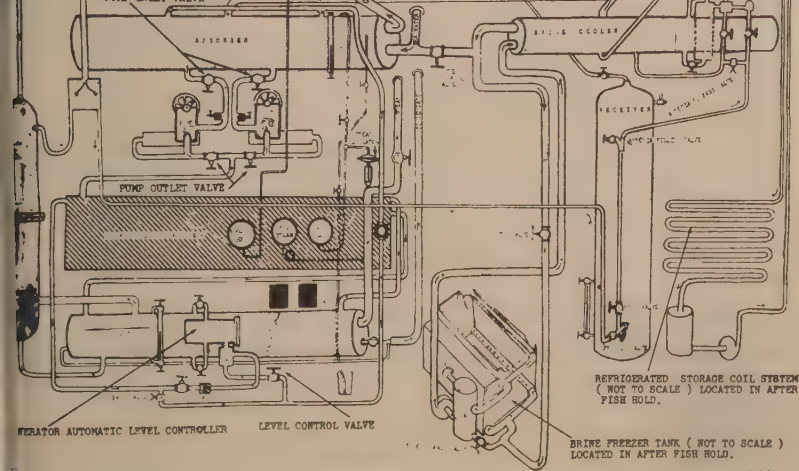
The same reasons for choosing this refrigerating system for the *Delaware* may make the use of the absorption system feasible on the large individual shrimp boats. First will be explained in very general terms the difference between the compression and absorption systems. This can best be done by the use of sketches of the two very elementary units shown in Figure 5.

Compression System

To make the systems easier to visualize, an ordinary pressure tank or receiver is taken as the starting point. As with any gas or liquid under pressure, when the expansion valve is opened and the gas released it expands rapidly and exerts a cooling effect. If released rapidly the expanding gas will cause metal or similar material in contact with it to cool to a temperature well below the freezing temperature of water. Therefore, as the expansion valve of the receiver is opened the expanding gas cools the coils of the evaporator, which in turn cools the brine in which the coils are submerged. This is the brine which is used to freeze the fish. After the gas leaves the evaporator it is pulled by suction into a mechanically operated compressor which subjects the gas to pressure. The compressed gas then passes into the condenser where it is chilled and condensed into a liquid. The liquid under pressure then goes to the receiver or original pressure tank and is ready to begin the cycle again.

Absorption System

In the absorption system the liquid pressure tank (receiver) and the evap-


PUMP INLET VALVE
PUMP OUTLET VALVE
RECEIVER
REFRIGERATED STORAGE COIL SYSTEM (NOT TO SCALE) LOCATED IN AFTER FISH HOLD.
LEVEL CONTROL VALVE
BRINE FREEZER TANK (NOT TO SCALE) LOCATED IN AFTER FISH HOLD.

URE 6—Diagrammatic view of the absorption refrigerating system installed on the *Delaware*.

orator, or brine cooling tank, are identical with that of the compression system, but here the similarity ends. Instead of going to a compressor the ammonia gas is discharged into a tank of water, known as the absorber. Since ammonia has the property of being absorbed very rapidly by water the ammonia gas is converted into strong aqua ammonia or ammonia water. The strong ammonia solution is drawn off at the bottom of the tank by a small pump and forced into a generator or heating tank. In this tank the steam coils which wind through the tank heat the strong aqua ammonia and boil off the ammonia gas. The gas then passes through a cool condenser and becomes a liquid. The liquid flows to the pressure tank or receiver and is ready to begin another cycle.

The main difference between the two refrigeration systems is the method of increasing the pressure between the evaporator and the condenser. In the absorption system this is accomplished by heat while in the compression system electricity or other mechanical means are used.

The two systems shown in the sketch have been oversimplified to facilitate a comparison of the principles involved. The complete absorption system as installed on the trawler, *Delaware,* is shown in Figure 6.

Advantages and Disadvantages in the Absorption System

On an overall basis, the operating costs of the two systems are approximately the same. The exact cost depends on the cost of the steam and electricity available. In regard to ease of operation our experience has shown that the absorption system requires considerably more attention than the compression system. This is one of its main disadvantages. The three principal advantages of the absorption system and the basis for our decision to use this system on the trawler, *Delaware,* are (1) lower initial cost, (2) less hold space involved and (3) much less electric power required.

The cost of the absorption system installed on the *Delaware* was $17,000 exclusive of wiring and power. A compression system of the same capacity was quoted at approximately $37,000 without wiring or power. And, contrary to general belief, $20,000 in some governmental agencies is the difference between operating and not operating. Some refrigeration engineers have told us that in order to maintain low temperatures a two stage system is necessary and this would require at least two compressors. If this is true the cost would be considerably higher than $37,000.

As installed on the *Delaware,* relatively little horizontal space is required for the absorption system, for the equipment is so arranged that the condenser, absorber, and heat exchanger are mounted above the other units of equipment. The fore and aft horizontal space occupied, including working space for the operator, is only 5 feet. This is an important factor aboard a fishing vessel for every foot of hold space is valuable.

To operate the 25-ton absorption system on the *Delaware,* only a very small amount of electric power is used—the major source of power being supplied by a steam boiler. If a 25-ton compression system had been used at least a 37 hp. electric motor would have been required, as determined by calculation. Refrigeration companies recommended at least a 50 hp. unit. In contrast with this the total electrical power used in the absorption system is approximately 2.5 hp. On the *Delaware,* as with most fishing vessels, the capacity of the generator is limited, consequently the installation of a sizable motor would also require an additional generator, which is both costly and requires additional space.

No reliable information has been found regarding the operating efficien-

small absorption systems, such as would be suitable for use on small rimp boats. One manufacturer has offered the information that absorption its of less than 10 tons capacity would not be as efficient as comparable ze compression units. This has not been confirmed.

Split Absorption System

In addition to the complete absorption installation there is one method of ing the absorption system on small boats which may be worth considering. It the split absorption system. In this system, which has been used experi- entally on refrigerated cars, only one half of the system is installed aboard e vessel, while the other half is operated ashore. The refrigerating equip- ent on the boat consists of only an ammonia pressure tank, evaporator ils, and a tank of water. At sea, when the boat requires refrigeration, the mmonia in the pressure tank is simply released through an expansion lve into coils to produce the cooling effect and is then passed into a tank water, where it is absorbed to form aqua ammonia. The shore plant, hich may serve many boats, removes the strong aqua ammonia from the at, puts it through the heating cycle to boil off the ammonia gas from e solution and then condenses the gas to form liquid ammonia. The liquid mmonia is then used to recharge the system on the boats.

A report on a test of this system in railroad cars is described in an article hich appeared in the June 1947 issue of *Quick Frozen Foods*.

For boats which will be at sea only a few days the split absorption system ay be feasible. For those on long trips of 10 days or more, the size of the mmonia and water tanks required may occupy so much more space that e system would not be feasible. For example, to maintain a temperature 0° F. in an insulated railroad car approximately 1000 pounds of liquid mmonia and 500 gallons of water were required for each 24-hour period. he advantage the split absorption system would have over ice is that the sys- m need not be turned on until refrigeration is needed. However, the biggest vantage by far is that the system is practically fool-proof and has no moving rts on the vessel installation.

At this point a word of caution is in order. The purpose of this information refrigeration is merely to offer suggestions as to what might be done aboard rimp boats. Before any type of refrigerating equipment is installed on any pe of fishing boat a competent refrigeration engineer should be consulted.

Future work on the freezing-fish-at-sea project will undoubtedly provide finite information which is applicable to the freezing of shrimp. The rel- vely small size of shrimp together with the limited amounts caught ring a 24-hour period should make freezing shrimp at sea a feasible opera- n.

Exploratory Fishing for the Little Tuna (Euthynnus lletteratus) Off the Atlantic Coast of the United States

C. B. Carlson, *Fishery Engineer, U. S. Fish and Wildlife Serivce, College Park, Maryland.*

Introduction

TEREST in the utilization of little tuna (*Euthynnus alletteratus*) began dur- World War II when several companies prepared packs from incidental

catches in an effort to develop new sources of food. The efforts of Mr. Cyrus Chilton of the Fish and Wildlife Service materially contributed toward developing interest in the species. While the flavor of the canned product was acceptable, the color, when processed by the usual procedures of the tuna industry, was somewhat darker than is desirable. Several years ago, the Fish and Wildlife Service and the Blue Channel Corporation independently conducted technological research to develop a better pack. In general, it was found that lower processing temperatures and increased cooking time enhanced both the color and flavor. Subsequently, commercial packs were prepared by the Blue Channel Corporation and were found to be quite acceptable to the trade. Since the catches of little tuna were seasonal and incidental to other fisheries, the need of obtaining a year-around supply was obvious.

Early in 1951 Mr. Sterling Harris of the Blue Channel Corporation, expressed interest in a cooperative arrangement with the Fish and Wildlife Service to explore for and to develop a little tuna fishery along the Atlantic Coast. The initial explorations were started on an informal basis to obtain preliminary information on problems which might be anticipated. In February 1951 the M/V *Barbet,* owned by Mr. John Robas, was made available for exploratory work and about two week's time was spent in trolling and searching for surface indications of little tuna in the area from Savannah, Georgia to Cape Canaveral, Florida at distances from 5 to 150 miles offshore. No surface schools were sighted and only 5 little tuna were caught on trolling gear. These were taken in waters having a depth of approximately 23 fathoms on a northeasterly line running off Fernandina, Florida to Brunswick, Georgia and alongside schools of porpoise which were thought to be feeding. On one occasion, a little tuna was captured near a spot of "color" beside a school of porpoise but the spot quickly disappeared, thereby precluding positive identification. While little tuna appeared to be associated with porpoise during February, there was no evidence of such association during exploratory work in the summer and fall.

Because of the apparent scarcity of surface schools and the necessity of conserving limited funds, operations were suspended temporarily. The two weeks of exploration indicated that little tuna might be difficult to find in commercial quantities and demonstrated the need for information on the seasonal pattern of occurrence to plan a program.

Reconnaissance Survey

A reconaissance survey was made by interviewing various persons associated with commercial fishing and by consulting the meager literature on the species. It was surprising that many fishermen, interviewed along the coast from the Carolinas to Mississippi and having offshore experience, had observed little tuna at some time or other. The reconnaissance indicated a wide and seasonable distribution of surface schools along the Atlantic and Gulf Coasts. Schools are normally seen over and outside the Dry Tortugas shrimp grounds with a degree of frequency from April through November and throughout the remainder of the year occasionally come to the surface for the waste discarded by shrimp trawlers. An analysis of observations by fishermen indicated that surface schools show progressively further northward along both the Gulf and Atlantic Coasts as the spring and summer advance followed by a southward regression as the fall and winter develop and that considerable variations of the sizes of the schools could be expected. It also developed that weather conditions might be a controlling factor on the occurrence of surface schools. Fishermen usually

bserved the schools during calm weather and bright sunshine but surface ndications were rare if the chop exceeded two or three feet, although tuna vere known to be present because of catches on trolling gear.

Exploratory Trolling Operations

In June of 1951 a formal cooperative agreement was executed between the Fish and Wildlife Service and the Blue Channel Corporation, whereby the Service contributed fishing gear, technical supervision and a limited portion of the operating costs while the Corporation furnished a vessel, crew and the balance of all expenses. It was obviously impossible to investigate the large area of distribution of little tuna as revealed by the reconnaissance survey in the time available. Consequently, the exploratory work was limited to the Atlantic Coast from Fort Pierce, Florida to Cape Hatteras, North Carolina and along the east coast of New Jersey.

Approximately two months were spent between Cape Hatteras and Fort Pierce in a preliminary searching for surface schools; in trolling to obtain specimens for identification and to locate little tuna when schools were not visible. Activities from June 10 through June 21 were in the area from Port Royal Sound, South Carolina to Fort Pierce, Florida, where little tuna were taken in varying numbers in random trolling during each day's operation at distances of 5 to 50 miles offshore. The most consistent fishing was found off the area from Cape Canaveral to Fernandina, Florida in depths of water between 10 and 15 fathoms, which, over much of the area, generally lies between 10 and 15 miles offshore. On occasions fish would be caught on all four lines from a given spot while from others the number varied from 1 to 3 fish but usually, when making repeated passes over the spot, few if any additional little tuna were caught nor could any surface signs be observed. This condition could be interpreted to imply scattered fish or small schools and was a general condition when the height of the sea exceeded three feet. Surface schools were sighted on four occasions off Fernandina, St. John's Lightship, Flagler Beach, Florida and off Brunswick, Georgia. Of these only the school off Flagler Beach showed evidence of having extensive tonnage. Whenever surface signs, ranging from a single fish to finning and jumping schools or schools working small fish were seen, the height of the sea was less than three feet.

Since the surface signs of little tuna off Georgia and Florida were not impressive from the viewpoint of a purse seine operation, the explorations from June 26 through July 13 were directed to areas between Port Royal Sound, South Carolina and Cape Hatteras, North Carolina. The weather with the exception of four days was generally unfavorable for purse seining but trolling was possible. Here again scattered fish were frequently taken by trolling and the best fishing grounds were between depths of 10 and 15 fathoms. Furthermore, the little tuna were usually found where the depth of water changed either abruptly by one to several fathoms as appeared to be the case between Fernandina and Cape Canaveral. Interviews with several party boat operators revealed similar impressions and their belief that feed congregated over these spots of uneven bottom. The best trolling was found in the area between Cape Lookout Shoals and New River, North Carolina and near the 2CR Buoy off Cape Romaine, South Carolina. One compact school showing evidence of extensive tonnage was found over an edge varying in depth from 9 to 14 fathoms southwestward of Cape Lookout. Several small schools were seen near the 2CR Buoy and one was registered on the automatic depthmeter. The scarcity of surface schools and the predominant southwest winds coupled with

rough seas which are common during the summer render that season unsuitable for consistent purse seining operations.

Explorations from July 17 through August 3 were directed to the southward from Port Royal Sound to Cape Canaveral. Schools of little tuna had been reported for two weeks prior to July 20 in locations first south and later north of Cape Canaveral. These, or perhaps different schools, were located on July 25 outside of St. Augustine and many schools were seen during the next 7 days as far north as Brunswick, Georgia, when adverse weather prohibited explorations. Areas from 2 to 5 miles wide and from 5 to 10 miles long over depths of water from 10 to 14 fathoms appeared to be literally alive with schools of little tuna varying in size from a few fish to extensive tonnage. The schools were only seen during calm weather but none were seen in choppy weather. Very few fish were caught from the schools by trolling but many individuals were taken in areas between the schools.

Exploratory Purse Seining Operations

Exploratory operations were temporarily suspended until August 27 while a converted aircraft rescue craft, 104 feet in length, was being rigged for purse seining. Exploratory purse seining was attempted between Port Royal Sound and Cape Canaveral until September 7 but consistency of operations was impossible because of mechanical difficulties. However, on August 29 many schools of little tuna were seen off the St. John's Lightship and one set was made. Inexperience of the crew and delays in starting the seine overboard resulted in missing the school but approximately 50 fish were caught. Further sets were prohibited because of failure of the main engine also used for pursing the seine.

Exploratory work was again resumed on September 13 and continued until November 3. The passage of two hurricanes coupled with the normal amount of adverse weather, usually expected during the fall, left only 6 days suitable for operating a tuna purse seine in offshore waters, although scouting and trolling was conducted whenever possible. It was planned initially to work off Morehead City, North Carolina where little tuna had been abundant in the fall of 1950, but unfavorable weather there and reports of little tuna off New Jersey caused operations to be shifted. For two weeks prior to our arrival at Manasquan Inlet, New Jersey, a substantial portion of the catches in the pound nets were little tuna and numerous schools appeared from the beach to a distance of 5 miles offshore between Manasquan Inlet and Sandy Hook. From September 21 through October 9 winds from all quarters, varying from moderate to gale in force, were prevalent on all but two days. With the exception of four days, when a hurricane passed offshore, the vessel was at sea in search of little tuna but only an occasional fish was taken on trolling gear and no schools were observed.

The base of operations was shifted to Morehead City, North Carolina on October 12 and explorations were terminated on November 1. During this time the weather was only suitable for offshore explorations on two days, consequently the research was confined to the area between Cape Lookout and New River which afforded some lee from the predominant northerly winds. Small schools were seen nearly every day within four miles of shore and three sets were made. On the first set the inexperience of the crew resulted in loss of the fish. The other two sets made on surface signs of 3 to 10 fish resulted in catches of 30 to 40 fish.

Very favorable reports on the presence of little tuna between Fernandina and St. Augustine were received on November 1. It was intended to shift operations to this area but a week of stormy weather resulted in a decision to terminate

he project. The most regrettable feature of the entire project other than the nfavorable weather, was that the purse seiner was not available during mid-ummer when many surface schools were seen. Had the converse been true, it s firmly believed that substantial catches could have been made.

The information gathered during the reconnaissance survey, the wide dis-ribution of the species as shown during trolling work, the heavy concentration f surface schools observed during the latter part of July and early August off lorida, tends to the conclusion that little tuna are abundant. The limited num-er of sets made indicates that little tuna are quite susceptible to capture by urse seines when surface schools can be found. Far more work is required to stablish the pattern of occurrence and to correlate this with weather conditions o provide a sound basis for exploiting the fishery.

Biological Information

Mr. Warren Rathjen, an undergraduate student in zoology at the University f Miami, participated in the exploratory trolling phase of the project and was elegated the responsibility of collecting a limited amount of biological infor-ıation with the view of obtaining preliminary ideas on the types of food, size istribution of the species, and spawning season.

ypes of Food

Many of the stomachs were opened in an effort to determine the feed of the tle tuna. Small herring-like fish constituted the largest portion of the stomach ontents which could be identified in the field, and squid were also present in nsiderable quantities. In many instances when herring were found in the omachs and little tuna were numerous, large masses of algae were observed on e surface giving the water a light brownish-green appearance. This algae was entified as *Trichodesmium* (*Skujaella*), and possibly played some part in the eding habits of the herring. Table I presents the recognizable items and their equency of occurrence in the stomach of a number of fish.

TABLE I

Species	*Number of Item Identified*
Round herring—*Etrumeus teres*	46
Squid	33
Spanish sardine—*Sardinella anchovia*	14
Unidentified fish	13
Round scad—*Decapterus punctatus*	9
Spanish mackerel—*Scomberomorus maculatus*	1
Mud parrotfish—*Sparisoma flavescens*	1

Size Distribution

A total of 226 fish were measured and a rough analysis aboard the vessel licated three general size groups as shown in Table II.

TABLE II

Size Range Inches	*Percentage*
15.4 to 19.9	15
20.0 to 24.9	68
24.9 to 32	17

These data were taken from fish caught on trolling gear from Cape Canaveral, rida to Cape Lookout, N. C. Because of the tender mouths, considerable

numbers of the smaller group were lost while the lines were being hauled. Had no individuals been lost by tearing of hooks from their mouths, it is quite probable that the percentage in the smallest group would have been somewhat higher. A rough analysis of the catches by sportsmen, who were trolling slower, using lead, and fishing deeper than our surface trolled lures, as well as exercising great care in playing the fish, indicated a higher proportion of large fish than is shown in Table I. A considerable number of larger fish as indicated by the heavy strike were also lost. These factors may in part account for the apparent low percentage in the largest fish group.

Spawning Season

During a period of taking data from July 3 to August 1, all of the fish examined showed evidence of being sexually mature or near that condition. On July 13, about 10 miles due east of St. Helena Sound, three females were taken which were partially spawned. From then until August 1, the gonads of the females were very full and individual eggs could be distinguished, or the gonads were partially collapsed. Many of the males taken between July 3 and August 1 were observed to have freely running milt. Of the 226 fish examined, 53 per cent were found to be males and 47 per cent were females. The gonads of fish taken in February and in October were very small.

The exploratory expedition when considered from the commercial viewpoint was not successful; however, a great deal was learned about the habits of the species and their seasonal distribution which should prove of great value in the collecting of sufficient information to eventually lead to the exploitation of this resource.

Studies of "Trash" Caught by Shrimp Trawlers in Florida

J. B. SIEBENALER, *The Marine Laboratory, University of Miami*

Introduction

A MATTER OF PRACTICAL CONCERN is the present large waste of trash caught in the course of shrimp trawl operations. Besides shrimp, this gear catches considerable quantities of fish and invertebrates which are now discarded.

This waste material can be converted into valuable meal, which is used in poultry and stock feeding. Wide interest has been expressed in the possibility of utilizing the waste. Estimates have been made of the amount of waste available but little is known of the true amounts caught, the relative amounts of the various components of the trash, nor the seasonal variation. The present study has as its object the investigation of these matters as well as a study of the economic feasibility of establishing reduction plants to process the shrimp trash.

The present report deals with observations from March 1951 to February 1952 carried out in behalf of the Florida State Board of Conservation.

Methods

Four series of observations on a bi-monthly basis have been made in the Mayport-Fernandina fishing area and five series were made on the Tortuga grounds. A total of 58 hauls have been examined.

Observations have been made aboard the shrimp vessels. Information collected on each haul consisted of the amount and size of marketable shrimp

* Contribution No. 63 from the Marine Laboratory, University of Miami.

e weight of game and commercial fish, and the amount of trash. The trash s divided into the components that could be used to produce meal and other eful by-products, and the non-usable part. The latter is composed chiefly of onges, holothurians and shells. The useful trash includes shrimp heads, under-ed shrimp, fish and miscellaneous crustaceans other than shrimp.

When the contents of the shrimp net were dumped on deck the pile was ughly divided into the various catagories listed above. Because of the large lume of material involved actual weights could not be obtained, but estimates re made of the weight of each lot. The advice of the fishermen was obtained making these estimates, since these men are experienced in approximating e weight of their catch and usually can guess with some accuracy. Checks re made on the accuracy of the estimates by actual weighing of portions of material, in some cases. The reported weights are, therefore, not exact, but ould be sufficiently accurate for the present purpose. Specimens of the organ-ns caught were preserved for specific identification.

Results

The ratio of total trash (including miscellaneous crustaceans, shrimp heads l fish) to headed shrimp averaged 2 to 1 on the Key West grounds. On the st Coast of Florida the ratio of total trash to shrimp averaged about 6 to 1. On the Tortugas grounds the only game and commercial fish were taken March. An average of 8 pounds of spanish mackerel per drag, or 2.5 per t of the total catch, were caught. In the Mayport area the game and food caught were at a maximum in May, with an average of 32 pounds, or 6.7 cent of the total catch, taken per drag. In September only 3 pounds, or per cent, were caught in an average haul. Whiting, blue crabs, flounder, nish mackerel, spots, bluefish and pompano comprised the catch of game commercial fish at Mayport.

On the Tortugas grounds an average of 10 pounds of undersized shrimp e discarded per drag, in August. In October an average of 212 pounds were arded. About 3 pounds of small shrimp per drag were caught on the May-t grounds in July. No undersized shrimp were seen in other observations e.

The dominant species taken in the Tortugas catches were mojarras, swimming

TABLE 1

SEASONAL COMPOSITION OF THE TRASH PER DRAG, IN POUNDS

	Quantity Useable Trash	*Quantity Shrimp Heads**	*Percent Shrimp Heads*	*Quantity Fish*	*Percent Fish*	*Quantity Crabs & Misc. Crustacea*	*Percent Crabs & Misc. Crustacea*
MAYPORT—1951							
	405	19	4.7	244	60.2	142	35.1
	325	52	16.0	160	49.2	110	33.8
	238	53	22.3	114	47.9	71	29.8
	337	171	50.8	138	40.9	28	8.3
KEY WEST—1951-1952							
ch '51	202	52	25.7	142	70.3	8	4.0
'51	159	57	35.8	69	43.4	33	20.8
'51	258	77	29.8	118	45.7	63	24.4
'51	423	346	81.8	35	8.3	42	9.9
'52	292	144	49.3	127	43.5	21	7.2

*Includes undersize shrimp

crabs, bronze grunts, rockfish and cuban snappers. Blue crabs, weakfish, croakers and spots dominate the catch on the upper East Coast grounds.

Only in May was any appreciable amount of unusable trash taken on the Mayport grounds. An average of 10 pounds per drag, or 2.1 per cent of the total catch, was caught. A maximum of 64 pounds, or about 21 per cent of the total catch, was taken in June. Eleven pounds, or 1.7 per cent, was caught per drag in the month of October at Tortugas.

On the Mayport grounds the amount of trash varied from an average of 405 pounds per drag in May to a minimum of 238 pounds in September (Table 1). Assuming that each boat makes 3 drags per day, the total trash caught ranged from a minimum of 714 pounds to a maximum of 1,215 pounds per day per vessel. On the Tortugas grounds the daily catch of trash per vessel was lowest in June, when an average of 477 pounds was caught, and highest in October, the average catch being 1,269 pounds in that month.

The weight of shrimp landed monthly in the Key West and Mayport-Fernandina areas separately is shown by statistical reports issued by the Marine Laboratory for the State Board of Conservation, in cooperation with the Fish and Wildlife Service (Florida Landings). Using the ratios for the amounts of shrimp to trash, the total amount of the latter has been estimated from these landings in the two areas, by months (Table 2).

TABLE 2

Estimated Amounts of Trash Calculated from Florida Landings

Month	*Year*	*East Coast*	*Tortugas*
February	1951	300,000	2,519,721
March	1951	640,823	3,313,570
April	1951	1,024,570	3,024,790
May	1951	1,216,564	3,548,012
June	1951	1,132,711	2,329,990
July	1951	1,039,881	1,154,370
August	1951	1,252,762	437,308
September	1951	1,411,743	363,518
October	1951	2,593,995	523,404
November	1951	1,920,792	649,542
December	1951	817,212	1,117,050
January	1952	325,179	2,647,934
Estimated Totals		13,676,232	21,629,209

On the East Coast the amount of trash is estimated at about 2.5 millio pounds in October, the peak month. In December through March the amount ranged from about 300,000 to 800,000 pounds. The annual estimated tota for the East Coast is about 13.7 million pounds.

From August to December the trash available in the Tortugas area was low ranging from 350,000 to 650,000 pounds per month. The peak was reached i May, with an estimated 3½ million pounds being caught. The total trash woul amount to about 21.6 million pounds annually from this area.

These annual figures have been broken down into the amounts of shrim heads, fish and miscellaneous crustacea. According to Vincent (1950) it re quires about 3 pounds of crab waste to produce one pound of crab meal. Th ratio is about 4 to 1 for trash fish and 5 to 1 for shrimp heads. Using thes figures, the amount of meal which could be produced annually at Maypo are as follows: shrimp bran, 321 tons; fish meal, 849 tons and crab meal, 61

ons. From the Tortugas grounds the quantities would be: shrimp bran, 1,095 ons; fish meal, 994 tons and crab meal, 450 tons.

The market value of fish meal is about $135 per ton at present. Shrimp bran rings about $100 per ton and crab meal about $60 per ton. Vincent (1950) as calculated the cost of producing a ton of meal to be $17.60. Before deduct-ig the cost of the raw material, a "profit" is shown of $117.40 for the fish ieal, $82.40 for the shrimp bran and $42.40 for the crab meal per ton of inished product. However, if the raw material were bought at one cent per ound (which is the approximate price paid for scrap fish in New England) its ost per ton of finished product would be about $80 for the fish, $100 for the rimp heads, and $60 for the Crustacean material. It now becomes apparent at a reduction plant would operate at a loss of $17.60 per ton on the shrimp ads and the crabs. On the fish meal a profit of $37.40 per ton could be ex-cted, if the operating prices quoted are accurate, and if present prices pre-ail. To insure a profitable operation it would appear that less than one nt per pound could be paid to the fishermen. Alternately, only fish scrap ight be bought, with the shrimp heads and crustacean scrap being discarded. either case it might be unattractive for the fishermen to handle the scrap. rther, since the shrimp heads and miscellaneous crustacea amount to over lf the useable trash, if they are not used the totals of available scrap set rth above would have to be greatly reduced.

A profitable scrap fish industry exists in New England despite a cost of raw terials of one cent per pound. However, the large volume of scrap available, nsisting almost entirely of the more valuable fin fish, is undoubtedly a major tor here. According to Sayles (1950) almost 90.3 million pounds of trash h were landed in New England during 1950. Here invertebrates were only 1 per cent of the total trash landings. In the two areas in Florida under con-s eration there is a potential availability of about 34.3 million pounds but out 21.9 million pounds, or 63.9 per cent of this would be shrimp heads and ner crustaceans. Snow (1950) reports that in an 8 to 18 hour fishing day in w England an average catch for a vessel would be about 30,000 to 35,000 unds. This is about 30 times what could be expected on the Florida grounds.

There is some possibility that trash utilization would be economically more sible if the end-product were high-priced condensed solubles (stickwater) tead of the lower-priced meal. Baughman (1950) has examined the possi-ty of manufacturing stickwater with meal and oil as the by-products. He lo suggests the use of "buying boats," equipped with macerating machines and rigerated tanks in the hold, capable of carrying up to 100 tons of liquid gurry. ese vessels could follow the fleet on the shrimping grounds and collect at iodic intervals. A representative of the Sharples Corporation, commenting n this idea, doubted that the fish could be liquified without being cooked. is problem would seem to justify some investigation.

The following conclusions are drawn as a result of this investigation. It uld probably be possible to establish a successful trash fish industry in rida if: (1) the plant could operate profitably on a seasonal basis. There r several months in the year when most of the fleet is either concentrated t Key West or on the East Coast of Florida; (2) if efficient methods are e sed for collecting the scrap. This would probably be best accomplished by un boat, collecting from the shrimpers when they are concentrated at norage. In Key West several hundred boats anchor in two general areas. It uld be possible to collect from the boats at the anchorage each morning. It uld be somewhat more difficult for a run boat to operate on the East Coast, ne the fleet generally operates along the whole coast from Jacksonville to

Fort Pierce for a few months of the year. However, if quick and convenient provisions are made for unloading at the docks, the fishermen would bring in the catch. It may be possible, then, to truck the scrap to the reduction plant. When the boats are away from port from two to four days they could only bring in the last day's catch. In such an event, the total scrap potential must again be reduced. The fishermen state that they will not collect scrap if they are forced to wait at the unloading platform for any length of time. Therefore, efficient unloading appears to be of prime importance to the establishment of the industry.

In a recent interview with a North Carolina fisherman, prices for trash were discussed. He stated that some North Carolina fishermen were willing to collect scrap for six-tenths of a cent a pound, for a plant in that area. It may be possible to interest the Florida fishermen at this price, if the unloading is handled in a swift and efficient manner.

List of Fishes and Invertebrates Caught
Shrimp Trawl Operations—Upper Florida East Coast

FISHES

Clear-nosed skate	*Raja eglanteria*
Cow-nosed ray	*Rhinoptera quadriloba*
Gaff-topsail catfish	*Felichthys marinus*
Sea catfish	*Galeichthys felis*
Thread herring	*Opisthonema oglinum*
Menhaden	*Brevoortia tyrannus*
Spanish mackerel	*Scomberomorus maculatus*
King mackerel	*Scomberomorus cavalla*
Cutlass fish	*Trichiurus lepturus*
Moonfish	*Vomer setapinnis*
Look-down	*Selene vomer*
Common pompano	*Trachinotus carolinus*
Bluefish	*Pomatomus saltatrix*
Harvest fish	*Rhombus paru*
Butterfish	*Rhombus tricanthus*
Rock sea bass	*Centropristes philadelphicus*
Common sea bass	*Centropristes striatus*
Sand fish	*Diplectrum formosum*
Weakfish	*Cynoscion regalis*
Banded croaker	*Larimus fasciatus*
Mademoiselle	*Bairdella armata*
Star drum	*Stellifer lanceolatus*
Spot	*Leiostomus xanthurus*
Croaker	*Micropogon undulatus*
Southern kingfish	*Menticirrhus americanus*
Gulf kingfish	*Menticirrhus littoralis*
Spade fish	*Chaetodipterus faber*
Common triggerfish	*Balistes carolinensis*
Southern stargazer	*Astroscopus y-graecum*
Toadfish	*Opsanus tau*
Midshipman	*Porichthys porosissimus*
Earl's ling	*Urophycis earlii*
Ocellated fluke	*Ancylopsetta quadrocellata*
Flounder	*Syacium papillosum*
Window pane	*Scophthalmus aquosus*
Tonguefish	*Symphurus plagiusa*
Sole	*Trinectes maculatus*

INVERTEBRATES

White shrimp	*Penaeus setiferus*
Spotted shrimp	*Penaeus duorarum*
Blue crab	*Callinectes sapidus*
Calico crab	*Arenarius cribrarius*
Squid	*Loligo pealei*
Squid	*Loligo brevis*
Whelk	*Busycon sp.*
Tulip shell	*Fasciolaria tulipa*

VERTEBRATES

Loggerhead turtle	*Caretta caretta*

List of Fishes and Invertebrates Caught
Shrimp Trawl Operations—Key West

FISHES

Sharp-nose shark	*Scoliodon terrae-novae*
Skate	*Raja texana*
Ocellated moray	*Gymnothorax ocellatus*
Sardine	*Sardinella anchovia*
Thread herring	*Opisthonema oglinum*
Lizard fish	*Synodus foetens*
Northern barracuda	*Sphyraena borealis*
Goatfish	*Upeneus maculatus*
Spanish mackerel	*Scomberomorus maculatus*
Common jack	*Caranx hippos*
Common pompano	*Trachinotus carolinus*
Banded rudderfish	*Seriola zonata*
Cobia	*Rachycentron canadus*
Rockfish	*Diplectrum formosum*
Lane snapper	*Lutianus synagris*
Bronze grunt	*Bathystoma striatum*
Littlehead porgie	*Calamus proridens*
Pinfish	*Lagodon rhomboides*
Mojarra	*Eucinostomus argenteus*
Ribbonfish	*Eques lanceolatus*
Common triggerfish	*Balistes carolinensis*
Fringed filefish	*Monacanthus ciliatus*
Orange filefish	*Alutera schoepfi*
Cowfish	*Lactophrys tricornis*
Southern blowfish	*Spheroides spengleri*
Scorpionfish	*Scorpaena calcarata*
Sea robin	*Prionotus sp.*
Shark remora	*Echeneis naucrates*
Midshipman	*Porichthys porosissimus*
Cusk eel	*Lepophidium sp.*
Soles	*Family - Soleidae*
Batfish	*Ogcocephalus radiatus*

INVERTEBRATES

Sponge	*Verongia longissima*	Squilla	*Squilla empusa*
Loggerhead sponge	*Spheciospongia verparia*	Spiny lobster	*Panulirus argus*
Russian helmet sponge	*Ircinia campana*	Stone crab	*Menippe mercenaria*
Spotted shrimp	*Penaeus duorarum*	Squid	*Doryteuthis plei*
Stone shrimp	*Eusicyonia sp.*	Fighting conch	*Strombus pugilis*
Spanish lobster	*Scymarides aequinoctalis*	Chinese alphabet	*Conus spurius*
Box crab	*Calappa flammea*	Tulip shell	*Fasciolaria tulipa*
Box crab	*Hepatus epheliticus*	Pecten	*Pecten gibbus*
Swimming crabs	*Cronius ruber*	Lion's paw	*Pecten nodosus*
Squilla	*Lysiosquilla maculata*	Star fish	*Oreaster reticulatus*

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Methods of Capturing Flying Fish

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BARBADOS is one of the few places in the world where the flying fish industry constitutes over 80 per cent of the fishery. The species sought is *Hirundichthys speculiger* which averages about one-third pounds in weight. At the present time they are sold for 6c each in the local market. In glutted periods this price is often reduced to 1½c each or less.

The boats used in Barbados are almost all sail boats of about 22-26 feet overall length, having a large oversized jib and an equally large mainsail. These boats are relatively fast sailers, and the ballast, which is usually all inboard, is shifted from side to side. Such boats carry a crew of three men.

Boats put to sea during the very early hours of the morning and generally endeavour to follow the prevailing current, since the flying fish are usually to be found travelling in the direction of the current. Up to 1949 observation of the current was the only method used to trace the movements of the flying fish.

In December of 1949 a Government research boat was added to the Fishery Department, and research work was started for the purpose of finding better methods for locating flying fish. This program is under the writer's direction.

The old methods for spotting and capturing fish were tried for some weeks with moderate success, following which new methods were tested. First, an examination was made of the plankton occurring in areas where flying fish were prevalent. To do this a small cylindrical plankton indicator was put over and towed at half speed (4½ knots) astern of the boat for periods of twenty minutes about 5-7 miles off-shore. The indicator screen was then inspected under the microscope to determine the occurrence of indicator species. There were often thirty or more types on the four-inch screen.

After some weeks of this plankton collecting it was evident that certain kinds of plankton were associated with the flying fish. Examination of the gills and upper stomach of freshly captured flying fish showed certain plankters to recur frequently. Henceforth, particular attention was paid to the numbers

of this plankton variety appearing on the screen of the indicator. Fishing trials were made if twelve or more of this plankton species could be seen on the screen. A majority of the specimens were crustaceans together with larvae of the sea urchin.

This phase of the research effort was most productive, and after some weeks of trials the relationship between the plankton and flying fish abundance was put to practical use. On many occasions, when the local fisherman returned with only a moderate catch, the research boat, working with the plankton indicator, returned with a catch many times above average.

These results have been reported to the Secretary of State's Advisor on Fishery Matters, Dr. C. F. Hickling, who considers these observations so important that it is proposed to send a trained student in plankton research to Barbados to further the studies.

Having decided to fish in an area, the boat is stopped, sails removed, mast unstepped and the hull is allowed to drift broadside to the prevailing current. A basket of foul-smelling bait is hung over the side, awash with the surface. As the boat rolls on the wave, the basket dips and pieces from the basket are scattered gradually over the area. A small amount of coconut oil or cotton seed oil, mixed with 2-4 gallons of sea water is thrown all around the boat to becalm the area, as well as make it possible to see the fish as they come near the surface and approach the boat.

This "baiting-up" period may last for an hour or more. Local fishermen, relying on the old method of current observation, may take 1½ to 2 hours to drift into an area. Working on plankton indicator it is usually possible to see fish within twenty minutes after stopping the boat. When few fish are seen it is customary to try hooking them with a tiny #12-#14 hook (English numbers) on fine crochet cotton lines. On some days it is possible for three men to hook over five hundred of these fishes. The fish gradually become accustomed to the boat and often come alongside. At this stage large hoop nets are put into the water. The fish then go towards the nets, which are lifted over the side of the boat. It is common to dip as many as five to nine at one time in one of the dip nets. This peculiar habit of the flying fish encouraged the investigation of the possibilities of the gill net. It was discovered that a gill net of 1⅞ inches stretched mesh, of a muddy green colour, was most suitable. The research boat uses three gill nets of small size (two of 15 yards each, and one of 30 yards), These nets are small for ease of recovery in case sharks or larger pelagic fish are encountered. With these three nets, the research boat has taken as many as 9,000 flying fish in six to seven hours fishing time; the best single haul was 1,005 fish in one 30 yard net, taken in 35 minutes. The local fishermen have realized the value of gill nets, and since 1951 many boats are using them.

After the interest of the local fishermen had been aroused in the gill net method of capturing flying fish, another type of net was introduced to the industry. This net is much larger, 50 yards long and 24 feet deep, and is very similar to the purse seine. The mesh of the net is 1⅞ inch stretched mesh.

One end of this net is put into the water and allowed to drift to windward of the boat. The far end is then hauled back to the boat by a side rope, thereby forming a horseshoe-shaped enclosure. By then the net has enclosed a fairly large area. The net is now closed by hauling a purse line, running through rings attached to the leadline. This prevents the fish from escaping by diving. At this moment many fish dart at the sides of the net and are gilled. This causes future work to disengage the fish but if the meshes were smaller, the fish would have

an opportunity to bounce the net and glide over the cork ropes. The remainder of the net is now closed, hand-hauled back to the boat and put on board. More than half of the catch may be gilled, but the remainder are free, as if captured by a purse seine net.

This net has been very successful. In the first haul made, it captured 1,040 fish, weighing over 300 pounds, in 15-20 minutes. In the second haul, 1,567 fish were netted. Two further hauls were made, bringing the day's total catch to over 6,000 fish. Due to an accident to one of the men who fell on the slippery deck, fishing operations had to be broken off, otherwise many more thousands could have been captured with the net in the one fishing operation. This larger net has been used on eight occasions between May 15 and June 30, 1951, and over twenty-five to thirty thousand fish have been taken by it. It is important to note that this net can be operated from all types of fishing boats, both sail and power, and whether decked or otherwise. It is believed that this is the first occasion when flying fish have been caught in this manner.

The Gear Development Program of the M-V Oregon

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AS AN INTRODUCTION to this report it would be profitable to discuss the present progress being made in gear development by the fishing industry itself in the Gulf of Mexico. For many years such experimentation by commercial boats was almost non-existent. Until late in the 1940's snapper fishermen were using the same techniques and gear employed by the fishery at its inception. Even today a large number of smacks travel around the Gulf under varying qualities of dead-reckoning. The location of good fishing grounds has been held in the highest secrecy, making it extremely difficult for a newcomer to break into the fishery. Until recently the shrimp fishery was moving ahead at only a slightly faster pace. During several decades there was practically no progress in trawl design. The recent discoveries of new shrimping grounds have rapidly changed the static attitude on gear, however. Until the Key West shrimp strike early in 1950, each area had its own favorite trawl style. The great influx of boats from all over the Gulf and South Atlantic States to the Key West grounds put the existing trawl designs on a competitive basis for the first time, and, of added importance, on a type of bottom previously unworked. Soon boats that had never used anything but flat trawls were trying out the so-called balloon trawls. Later, trawls embodying features of both styles were used. Many small refinements appeared, some of which were rejected, and some retained. Several trawl makers in the north Gulf tried to make balloon trawls without ever having seen one, and some peculiar designs were produced. Biloxi fishermen, not quite willing to go all the way with a new idea, were tying the wing-tips of balloon trawls up close to the trawl doors instead of allowing the customary 25 to 30 feet between wing-tip and door. A few extremely courageous New England boats were even trying to use roller type trawls on north Gulf snapper grounds. In other words, within a few months, trawl experimentation had become the rule rather than the exception.

By early 1951 many fishing areas had developed or adopted new or differently rigged trawls. Even in the period of the most intense experimentation, however, designs never exceeded the fishermen's sense of practicability.

With these developments came the rapid acceptance of the sonic depth

recorder as a piece of essential fishing equipment. Among the first to recognize the value of this instrument were the snapper boats. It rapidly proved to be an invaluable aid in locating old lumps as well as many new areas, saving many days of searching each trip. Early in 1950 boats on the Key West grounds found it to be useful in preventing loss of gear when working on unknown bottoms. Almost all new boats are equipped with depth sounders and many experienced fishermen now wonder how they got along without one.

With this general situation in the Gulf shrimp and snapper fishery as a background, the Fish and Wildlife Service planned its program of gear development. It had become apparent that if attempts were made to take on the job of refining gear now in use simply to make it more efficient, the program would find itself competing with commercial boats and would almost certainly do little more than duplicate many ideas already tried and rejected by the fishermen. This, then, left the alternative of developing and testing new techniques and equipment as well as surveying the gear of other fisheries for ideas that may be applicable locally. Several such projects are now under way at the Pascagoula station.

The reversing thermometer, used to obtain bottom temperatures, is one instrument that looks very promising, as an aid in the off-shore shrimp fishery. Results from the first year of trawling show an interesting correlation between catch rate (used as a measure of abundance), the size of the individual shrimp, and the bottom temperature. Results to date on red shrimp (*Hymenopenaeus robustus*) in deep water show a very definite maximum temperature above which none of this species has been taken, although they have always been found below it. If this continues to hold true, the reversing thermometer will almost certainly rank as an important component of the gear necessary to exploit this potential resource. This is one of the best examples of what are termed long-range projects. It will probably take several years to establish a reliable pattern of temperature correlation if such a pattern can be established.

It is believed that loran receivers will eventually prove to be as invaluable as the depth sounder to all fisheries that work beyond the sight of land. Using loran fixes, it is hoped eventually to plot all areas of good snapper fishing bottom. A few boats operating in the Gulf have already installed loran receivers. In time this will enlarge the secret and exclusive society of snapper captains to include practically anyone who is interested in engaging in this fishery.

The program has been cooperating with the Warren Fish Company of Pensacola in testing their new electric snapper reels. These, although still in need of modifications, have proved to be an important step in the mechanization of that industry. Tests aboard the OREGON have repeatedly shown that the amateur can easily catch as many pounds of fish as the most experienced fisherman and many times catch more, when both are using reels.

Another experiment involved trying traps to catch snapper. Catches have been so poor, however, that the project has been discontinued. About ten different designs of traps of several different sizes were tried in different areas throughout the Gulf between January and June of 1951.

In the shrimp fishery it was decided to pursue a program of testing trawls of radical design. It has become obvious that such a program is not conducive to quick results. There is a possibility that basically the present gear is close to optimum, and that any drastic departure from it will not produce a successful gear. However, if one of these modified trawls does prove to be more efficient or, as efficient but more economical, a valuable contribution will be made

the fishery, perhaps permitting boats to work in areas now unsuitable for shrimping because of adverse bottom conditions. In addition there is a very definite need for trawl experimentation. The primary reason is that present gear is not sufficient to explore and adequately sample some areas of reported or suspected commercial potential. Coral and shell on the north coast of Yucatan, soft mud in the newly discovered red shrimp beds, large numbers of loggerhead sponges on the Florida coast, and the mud lump areas off the Mississippi Delta have been main concerns to date, and all these present different problems in adapting or designing gear. If gear can be developed to overcome these obstacles, a major problem in the exploitation of a possible commercial discovery will be well on the way to being solved.

Attempts are being made to evaluate the various components of shrimp trawls, to learn how different cuts and shapes, hangings, and the materials of a trawl affect catch-rate and selectivity of species. Trawls have been constructed and tested with the bottom completely removed back to the funnel, as have trawls with extremely lengthened jibs and wing-tips and with new jib shapes. After each series of tests the trawls are examined for areas of particularly severe strain or apparent poor performance. Whenever a possible improvement is devised it is incorporated.

The gear development program of the OREGON thus seeks to supplement, rather than duplicate experimentation by fishermen, and to work in fields which the industry cannot conveniently carry out trials.

Oceanographic Instruments, Their Use and Application in Marine Biology

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Introduction

Special problems in marine biological work may often require detailed data on only one or two of the major environmental oceanographic factors, while general marine biological problems usually require comprehensive data on all of the environmental conditions, i.e., salinity, temperature, oxygen, nutrients, transparency, currents, and bottom sediments. To obtain such data scientists have employed both biological and oceanographic instruments.

Many of the instruments used in marine work are suited to the requirements of both the marine biologist and the oceanographer. Since some of the present-day devices have been used successfully by both groups for years, it might be of value to call the attention of biologists to other recent developments in the field of oceanographic instrumentation.

Basic Oceanographic Instruments

Two basic oceanographic instruments, the Nansen bottle and bathythermograph, the conditions they evaluate, and their application to marine biology will first be described.

A Nansen water bottle or sampler, for collecting serial samples at sub-surface levels, is closed at any desired depth by sliding a messenger down the wire when the proper amount has been paid out. The trapped sample is not contaminated by water at higher levels nor lost by leakage after the bottle is brought on board. To enable temperatures and water samples to be taken at the same

depths, the water-sampling bottles are fitted with frames in which two or more reversing thermometers are placed.

The bottles are closed automatically by a messenger, released from the deck. Each bottle in turn releases a messenger to close the bottle below it. The vessel must be stationary, and sufficient time must elapse for the thermometers to record the temperature. From such a cast the temperature can be read to the nearest 0.01°C, and there is sufficient sample, 1250 ml., for nutrient determination and salinity and oxygen titrations. The possible depth of sampling is limited only by the length of wire available. Usually 5/32″ diameter aircraft control cable is used with Nansen bottles.

The bathythermograph, (or "BT"), is designed to obtain a record of the temperature in relation to depth. It can be operated while the ship is underway at speeds up to 18 knots. Best results, however, are obtained when the speed is not in excess of 12 knots.

As the BT is lowered in the water a trace is made on a smoked glass slide through the interaction of a pressure element with a thermal element, graphing the water temperature against depth. From a calibration grid, individually prepared for each instrument, the temperature can be read to the nearest 0.2°F. or 0.1°C. Models are available which can measure temperatures in depth up to 300 meters. Others give more expanded temperature traces in depths up to 60 and 150 meters. The wire used with the BT is usually either 1/16″ or 3/32″ diameter, and a length of about twice the maximum sampling depth is required, to allow for a wire angle of about 60°.

This instrument is useful for quick location of water of a particular temperature at a given depth. When such areas are located, specialized salinity- temperature-depth determining instruments may be employed to explore the region further.

Dual-Purpose Sampler-Type Instruments

Three outstanding, dual purpose sampler instruments have been developed since World War II. They are the Spilhaus Sea Sampler, (Woods Hole, 1948), the Auxiliary Sea Sampler, (Woods Hole, 1949), and the Wohlenberg Water Sampler-Sediment Trap, (Wohlenberg, 1950).

Spilhaus Sea Sampler

The Spilhaus Sea Sampler is a modification of the standard bathythermograph, to permit the collection of water samples, while under way, at predetermined depths, while simultaneously making a BT trace. The instrument consists of a bathythermograph around which are arranged twelve small sample bottles. These bottles are closed automatically at predetermined depths by pressure, as the instrument is brought to the surface.

Tests with the sea sampler have indicated that there is a lag of about 2 meters when operating from a stationary vessel. When the vessel is underway the error is reduced by vibration to a very small fraction of this figure.

Auxiliary Sea Sampler

A specialized sea sampler of single-bottle design is attached to a BT and arranged to trap water at the lowest depth of the instrument's traverse when used from a stationary or moving vessel. This is accomplished by utilizing the deep dive attachment, a standard accessory for the BT.

The use of the instrument is limited, in that the depth at which the sample is to be taken is not closely predetermined, but is largely left to chance. Also only a single sample can be obtained during a BT dive. These disadvanta

are partially outweighed by the fact that only minor BT modifications are necessary to attach the auxiliary water bottle.

Wohlenberg Water Sampler-Sediment Trap

This is a horizontal water sampler, which serves a dual purpose: as a water sampler and as a sediment trap. The instrument is lowered to the bottom from an anchored ship, allowed to orient itself into the prevailing current and then vented by means of a messenger. A second messenger is used to close the sampler, and trap its contents.

The sample can be collected to within two centimeters of the bottom, and under such conditions produces a representative sample of the water immediately adjacent to the bottom. These samples can be analyzed for salinity, oxygen, bacterial content, plankton concentration, and sediment load.

These three dual purpose sampler-type instruments have obvious application in pollution problems of marine waters. In many cases it is extremely difficult to trace the horizontal and vertical distribution of a pollutant except by means of sampling. Such sampling is often cumbersome and slow, especially in delineating the boundaries or interfaces of pollutants. Both the Spilhaus and Auxiliary samplers provide quick means of obtaining representative samples over large areas. The Wohlenberg sampler is particularly useful in locating pollutants with a density greater than that of water.

Dual Purpose Electronic Instruments

In all sciences electronic instruments are replacing or supplementing the mechanical instruments of yesterday. Electronic instruments are popular because they reduce the amount of physical labor necessary to perform a task. Typical new developments in the field of oceanography in electronic devices are the Salinity-Temperature-Depth Recorder, (the "STD,") (Jacobson, 1948) and the Conductivity-Temperature-Depth instruments, (the "CTD,") (Chesapeake Bay Institute, 1951). The development of the STD and the CTD indicates the scientists' need for faster, more accurate instruments.

Salinity-Temperature-Depth Recorder

The Salinity-Temperature-Depth Recorder consists of a sub-surface head, a mechanical measuring circuit, and a computer. The sub-surface head contains three parts: a resistance thermometer constructed of small nickel wires drawn to a fine tube and sealed at both ends; a conductivity cell, formed by the insertion of three platinum-lined electrodes in a plastic tube protected by heavy bronze tubing; and a Bourdon depth element constructed of beryllium copper alloy. The free end of the depth element carries a contact that moves over a wire slide in the manner of a rheostat, thereby converting a position movement into electrical values which can be transmitted to the computing and recording mechanisms on the ship's deck.

The measuring and computing mechanisms are electro-mechanical servo systems. A Wheatstone bridge circuit is used to measure the resistance of the thermometer unit, while the readings of both the temperature unit and the conductivity unit are fed into a computing mechanism that converts the values to salinity. Depth in feet, Fahrenheit temperature, and salinity are recorded against time by pen traces on a paper tape.

In field test the extreme range of errors of the STD was from plus 0.18 to minus 0.30 parts per thousand salinity and from zero to 1.6°F. temperature. The depth range is from zero to 90 meters.

Conductivity-Temperature-Depth Instrument

A second combination salinity-temperature-depth instrument is now being developed for use in shallow waters; i.e., less than 300 feet. This instrument, the CDT, measures conductivity, temperature, and depth with a reaction time of less than 0.4 second. The bulk of the device is one-third that of the STD. Values are indicated directly on four-digit counters.

The submerged head, lowered by its electrical cable, indicates by an amplifier and dial system on deck the conductivity, temperature and depth of the water through which the head is passing. A permanent record of the conditions may be obtained by adding a mechanical recorder in conjunction with the amplifier, or by photographing the readings of the counters and a clock.

Field tests indicate that the temperature element is accurate to 0.05°C., while the conductivity element is sensitive enough to produce figures accurate to 0.5 milimhos. The depth element is still under development.

Either the STD or the CTD can be hull-mounted to give continuous, instantaneous readings of horizontal distribution of the temperature and salinity. They are extremely valuable in locating regions of salinity or temperature difference and can cover large areas in much less time than the older sampling techniques.

Bottom Sampling Instruments, Mechanical and Electronic

Bottom conditions often provide the best key to the location of suitable grounds for particular types of marine organisms. Shrimp of economic importance are most often located over and on mud bottoms. Generally, oyster propagation is most successful on shell bottoms. Various species of ground fish show a preference for a particular type of bottom, and the determination of bottom conditions provides an aid in locating new fishing grounds. In pollution studies bottom sediments may disclose the presence of a heavy contaminant several days after the initial introduction of the pollutant.

Types of bottom sediments may be determined several ways, depending upon the data required and the time allotted to make the survey. The superficial layer of bottom sediments may be examined by using the Underway Bottom Sampler (Emery and Champion, 1948) or the Soundfish (Lafond, Dietz and Knaus, 1949). In coring operations to determine the depth of sediments, the Kullenberg Piston Corer, (Scripps, 1950), works equally well in sand, mud, shell and clay.

Underway Bottom Sampler

This instrument for collecting bottom samples was designed to be used from ships moving at speeds up to 10 knots. The sample taken shows only the superficial layers of the sediments.

A connector or swivel on the sampler is attached to a bathythermograph cable, or similar equipment. The fish is allowed to sink freely until it strikes the bottom. When this happens the retaining cup is driven back into the tube releasing the spring-loaded lid. The scoopfish is then brought to the deck, the cup removed and the sample examined.

In skillful hands samples up to fifty grams can usually be obtained. When working over shell or rock bottoms, mechanical difficulty in the closure of the lid sometimes results in loss of the sample. A prospective solution to the problem of proper closure is the redesign of the lid and the addition of a spot rubber seal between the lid and fish case.

Soundfish

To meet the requirements of rapid bottom sediment determination, Lafond, Dietz, and Knauss developed and tested a sonic sampler consisting of a Brush hydrophone encased in a water-tight metal cylinder. The metal case provides protection for the hydrophone and forms a sounding board as it is dragged along the bottom. Circular ridges on the outside of the case increase the frictional sound developed. As the case scrapes the bottom the sound is picked up by the hydrophone and transmitted up an electrical cable to listening equipment. Suitable equipment consists of a battery-powered audio amplifier and headphones. The amplifier should be operative in the 500 to 10,000 cycle band.

The sounds produced by gravel, mud, shell, and sand are each distinctly characteristic. Rock produces loud clangs, sand makes a heavy rasping noise, and mud produces a quiet swishing noise. In combination of fine and course material the sound of the coarse fraction dominates. Under good condition a trained observer can differentiate between the sounds made by fine and coarse sand. A similar device has been employed by Woods Hole Oceanographic Institution to differentiate between sand, gravel, and clams.

Such an instrument is especially useful in delineating the horizontal boundaries of various bottom types and reduces the amount of working time necessary when looking for a particular type of bottom. A permanent record of the sounds produced and the bottoms sampled may be obtained by using a pen recorder coupled with the audio amplifier.

Kullenberg Piston Corer

The Kullenberg Piston Corer, with modifications by various users, operates well in all types of bottom sediments. The latest modifications made by the Hydrographic Office are in the cutting head and piston size. By reducing the diameter of the piston and cutting head a plastic tube may be inserted into the twelve-foot barrel. Cores taken in the plastic tube may be stored with little difficulty for future analysis. For marine bacteriological studies the cores must be extruded within a few hours of coring operations to prevent marked changes in the flora of the core. The plastic inserts can be reused.

The instrument and release mechanism must be lowered from a stationary vessel. As the pilot weight touches bottom the corer is released to penetrate the sediments. The corer's free-fall distance is determined by adjusting the length of the pilot weight line. Normal free-fall distances are less than thirty feet. Several lengths of tubing may be used, convenient ones being 20, 15, 12 and 6 feet. The use of any one section or combination of sections works equally well. Cores of thirty feet and greater have been made in soft sediments.

Current-Measuring Devices

Current meters of many designs have been used both by the biologist and the oceanographer to determine the current velocities in marine waters. Probably the best known, the Ekman and Price meters, have been used successfully by the biologist in bays and near-shore waters to determine the current flow in relation to fish migration and marine life dispersal. The mass transport of plankton and marine invertebrates to and from the bays and shelf waters is greatly influenced by the currents of the near-shore waters. Detailed knowledge of the currents is necessary to understand the transport of larval forms of oysters, crabs, etc., from the point of hatching to the point of attachment or residence.

Three other instruments for current measurements are relatively recent de-

velopments in oceanography. The Roberts Radio Current Meter, (Roberts, 1950), and the Schaufelrad (Paddle-wheel) Current Meter as reported on by Boehnecke (1948), are mechanical instruments for measuring currents. The Geomagnetic Electrokinetograph, (von Arx, 1950), presents a new electromagnetic method for measuring the velocities of ocean currents from a ship underway.

Roberts Radio Current Meter, Model II

The Roberts Radio Current Meter consists of three parts: the buoy, transmitter, and meter. A buoy, of ship-like design, anchored at a particular station contains a battery-operated radio transmitter and antenna. Below it is streamed the Roberts Current Meter, at the desired depth, connected by an electric cable. The meter impeller reacts to the flow, actuating an interior contacting mechanism controlled in part by a magnetic compass. Contacts are made within the meter for current direction and velocity, telegraphed to the buoy and transmitted from the buoy as a radio signal. At a radio receiving station, either ashore or afloat, the signals are received, amplified and recorded by means of a chronograph. Observers tune the individual radio buoy frequencies, record the signals, scale the tape, and tabulate the values for each current station.

Accurate measurements are not possible in currents of less than 0.3 knots. The radio transmitting range is limited to ten miles. While little can be done about the first limitation, the second can be bettered by redesign of the radio transmitter.

Schaufelrad Current Meter

Another moored and buoyed current meter, the Schaufelrad (Paddle-wheel) Current Meter, is a self contained, continuous recording instrument. This device is moored into position with an anchor and held off the bottom with a buoy. The buoy also aids in the recovery of the instrument. The size of the instrument, 170 cm. long and 58 cm. wide, makes it impossible to use the instrument closer than 100 cm. to the bottom.

A paddle-wheel mounted in the top of the bomb-shaped shell is turned by the currents. An intermittent light source records on photographic film strip the turns of the paddle-wheel and the direction as indicated by a compass. After the desired period of operation, up to four weeks, the meter is raised, the film strip removed and developed. The traces of light are scaled to determine the water current direction and speed adjacent to the instrument during the period of immersion.

Geomagnetic Electrokinetograph

As far back as 1832, (von Arx, 1950), there was an attempt to measure electric current flowing over a short range in response to water motions. Little was accomplished until 1918 when F. B. Young and his associates used both moored and drifting electrodes to measure electric currents generated by tidal motions.

The duplication of Young's experiments in the autumn of 1946 led to the development of the Geomagnetic Electrokinetograph or "GEK." The electromagnetic principle on which the GEK operates is simple: sea water, being a solution of electrolytes, is a good electrical conductor. The motion of this conductor through the earth's magnetic field produces an EMF detected by a pair of silver-silver chloride electrodes towed behind the ship. They are spaced 1 meters apart and are streamed astern away from the magnetic and electrical influences of the ship itself. The shipboard end of the cable is connected with an industrial recording potentiometer.

On any given ship's heading, the reading is proportional to the component current perpendicular to the course. Through measurements of the potential fferences on two courses at right angles, the component velocity compon-ts in these two directions are determined, and the vector sum or resultant of ese velocities is the surface water current vector for that locality.

For shore stations the GEK may be adapted for use in a channel, pass, or en arm of any estuary where turbulence is slight and where upwelling and nking is negligible. As the electrodes may be mounted on each side of the annel and connected by a cable the horizontal velocity of the water passing tween the electrodes may be measured. Because it is awkward to reverse the ectrodes to calibrate the instrument when making measurements at a fixed ation, it is necessary to consider the measurements of potential recorded dur-g times of zero tidal flow. The measurements of potential recorded during nes of tidal flow are computed with the measurements made during slack ater. This comparison is used to determine the water current flow through e channel.

The use of the instrument is limited to areas more distant than 20° latitude m the magnetic equator, as the vertical component of the earth's magnetic ld is involved. Also, highly industrialized areas are to be avoided since stray unds and intermittently operating electrical machinery may mask the signals m natural sources.

Biological Net

The last device to be discussed is one developed for problems concerned h the larger organisms in relatively deep oceanic waters. The Midwater awl or Tucker Net, (Scripps, 1951), was designed to operate in depths up 1200 meters and has been found satisfactory in depths up to 3000 meters. e net is extremely productive of bathypelagic forms, but has not been tested shallow water. The catches have been in good condition after 4-knot tows.

The net is towed from a ⅜ or ½-inch dredging cable. The towing cable is ckled into the main bridle of the net through a swivel. The mouth of the is held open by a lower beam of "V" construction. A depressor serves not y to depress the net but spread the mouth as well.

The net is an asymmetrical pentagonal pyramid with five main hauling lines, ning from the five points of attachment to the ring just forward of the cod . Net construction is of 2½-inch stretched mesh. A ¼-inch stretched mesh r is attached just forward of the cod end and extends the entire length of cod end. The mouth opening of the net is ten feet across, and the overall gth is about thirty-five feet.

As previously mentioned, the net has not been tested in shallow water, but ging from its efficiency in deep water it should serve well in the collection free-swimming marine organisms normally found in waters of ten fathoms greater. Field tests indicate that the Midwater Trawl meets the specifications net long needed to collect small fish normally inhabiting very deep waters.

Accessory Equipment

long with the development of instruments there has been development of ssory gear. Such gear as the Automatic Time Release Device, (Scripps, 9), the Semi Expendable Concrete Depressors, (Scripps, 1949), and High g-Ratio Depressor, (Scripps, 1950), play their parts in the operation of ogical and oceanographic equipment.

Conclusion

Development and design of new equipment is a problem for both the biologist and oceanographer. The use of oceanographic equipment should not be limited to the science of oceanography for these instruments show promise in marine biology. The instrument's transposition from the field of oceanography to that of biology is, in cases, a problem of modification or redesign while in other cases it is only a problem of application. Newer and better instruments are needed in both fields and it is the responsibility of the men using the instruments to make their needs known or to modify and redesign existing instruments to their particular needs.

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Fish Culture Project in Haiti

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THE POSSIBILITY of developing fish culture as a source to supply protein fo to the people in Haiti was first visualized by Professor Ernest F. Thompson Yale University. In the 1948 Report of the United Nations Mission to Ha Thompson observed, "Haiti possesses a very considerable area of lakes, rive irrigation canals and ditches, vast land capable of being flooded and a gr variety of shallow lagoons, both salt and fresh; and these are at present productive or produce only at an extremely low level, and most of them ha little or no agricultural potential. In addition there are considerable rice fi areas the flooding of which is contemplated." Further, in connection with culture, the Mission recommended, "Before deciding on a program of pc culture development the service of a first class specialist familiar with succes practices in other countries should be secured for making an extended sur

in the light of such survey decision is taken to embark on fish farming, the ecialist should be retained for a number of years to lay out pilot operations nd supervise their implementation; further steps should be taken to train at ast two local men in the principles of fish culture, these men to be respon- ble for following up the plans of the specialist."

The fishing industry of Haiti has not yet been developed. Marine fish land- gs are extremely small, being estimated at about 1,000 metric tons per annum, nd the harvest from the fresh waters is much smaller. The country had to im- rt each year an average of 3,050 metric tons of salt dried and hard smoked h, valued at 2,061,310 gourdes or $412,260 for the fiscal years 1916-17 to 48-49. The total of locally produced and imported fish are only enough to pply the Haitian population of 3.2 million about 1.2 kg. per capita per num. Animal proteins of other kinds are also extremely scarce in the country d the people do not receive a balanced diet.

The development of the marine fisheries is usually regarded as a good easure to meet such requirements of the country. However, no achievement ong this line can be expected unless a considerably long period is to be spent training fishermen to handle fishing boats and gear, and some other prac- es that will give quicker results must be sought at the same time. Fish culture recommended for the reason of its comparatively simple technique and sy application. It can become an integral part of the rural economy when it well established.

Although it cannot be said at present that the Haitian peasants are fish- ing people like the islanders of many other parts of the world, there is no lication that they have any prejudice against eating fish. The purchasing wer of the peasants is low, but if they can produce fish themselves from nds in their back yards, rice fields, rivers and lakes where the cost of pro- ction is correspondingly low, they would have no difficulty in procuring this uable food.

To implement the recommendation of the United Nations Mission the Gov- ment of Haiti requested the United Nations and the specialized agencies to ntinue the Expanded Technical Assistance Programme on various fields of rk in the country. Among the experts sent to Haiti the writer was assigned the Food and Agriculture Organization (FAO) on June, 1950 to carry out substantial survey with a view to formulating a practical scheme on fish ture development.

A field survey was considered necessary to collect information for drawing a plan of action. Beginning in June 1950 the survey was carried out in operation with the staff of the various sections of the Department of Agri- ture.

The first important point of the survey was to find out if there are any genous fishes which could be used for profitable cultivation in ponds. condly, attention was paid to the natural freshwater systems such as rivers lakes, the sources of water supply and the land available for pond con- ction. Particular attention was paid to the periodically flooded rice fields, mps, rivers and lakes. Thirdly, it was necessary to find out what kinds of d material, such as peanut meal, rice bran, oil cakes, copra waste, and ilizers were available. Fourthly, the climatic and meteorological data, which important with reference to selection of species of fishes for cultivation to pond management, were collected as far as possible. Finally, observa- s on socio-economic condition of the people were made, and evaluated with rence to the planning and execution of the prospective fish culture project.

The survey covered the typical low land areas such as Plaines du Cul-de-Sac, de Léogane, de Petit-Goave, des Cayes, de l'Arcahaie, Artibonite and du Nord. Many rivers and lakes were visited and fish were caught for examination. The result of the survey can be summarized as follows:

The existing waters are strikingly unproductive, evidently due to the absence of prolific and fast growing fishes. Even in the big rivers like the Artibonite, the Estère, la Ravine du Sud, the Grande Anse and in the Etang Miragoane, Etang Saumatre only two groups of fishes, the poeciliids and the cichlids, are common. In the family Poeciliidae, *Gambusia dominicensis* Regan, *Limia melanonotata* Nichols and Myers, *L. nigrofasciata* Regan, are most common. *Cichlosoma haitiensis* (Tee-Van) was the only species observed of the family Cichlidae. The poeciliids are small, extremely prolific fishes. They are excellent mosquito larva destroyers. *Cichlasoma,* on the other hand, grow slowly and are unable to propagate well. In the flooded rice fields and basins along the Rivière de l'Estère of the Artibonite Valley cichlids are produced, but of not large enough quantity to be of importance. The only fishes of certain economic importance are the young of *Sicydium plumieri* (Bloch) and *S. punctatum* Perugia, which multiplies by millions, probably in brackish waters in the bays and along the coast and ascend rivers in the months of January to April. Also to be found are the young of the fresh water eel, *Anguilla rostrata* le Sueur. Individuals of the following marine species are usually caught in the lower part of the rivers: *Megalops atlanticus* (Cuv. & Val.), *Mugil liza* Cuv. & Val., *Mugil curema* Cuv. & Val., *Mugil trichodon* Poey, *Agonostomus monticola* (Bancroft), *Centropomus undecimalis* (Bloch), *Centropomus pectinatus* Poey, *Centropomus ensiferus* Poey, *Gobiomorus dormitor* Lacépède, *Dormitator maculatus* Bloch, *Eleotric pisonis* (Gmelin), *Gobiosoma* sp.

Among these marine species which ascend rivers the fresh water mullet, *Agonostomus monticola,* is most common and can be caught in considerable quantities, although areas where large schools of young *Agonostomus* might be found have not been discovered.

Most of the valleys, low land areas, plains, mud flats, and mangrove swamps are suitable for pond construction, and in many cases water supply is adequate. Many large areas of rice fields are flooded during the rainy season for several months, a period long enough for a certain hardy, rapidly growing and prolific species of fishes to thrive and to give rise to high yields. Several lakes can be made more productive by stocking with certain types of fish and letting them propagate for a number of years until a stage of maximum production is reached.

A favorable condition for fish culture development in Haiti is the absence of predatory freshwater fishes. The so-called fresh water eel, fresh water mullet, the gobies, the snooks, the snappers, etc. are mild predators but all of them spawn in the sea and only a few (e.g. the eel and the mullet) ascend into rivers and lakes far inland. Their chance of entering fish ponds is limited; even in brackish water ponds many sea fish can be screened out at the sluice where water is admitted. In some of the bigger lakes turtles are found, but because of their size and breeding habit they are easily placed under control. It is fortunate that no one has yet introduced any predatory fish into this country purposely or by mistake.

Many kinds of cheap food material such as peanut meal, cotton seed cake, copra waste, rice bran, kitchen waste, etc. are available in considerable quantity in some parts of the country.

The climate of Haiti is tropical. For the greater part of the country the

atmospheric temperature ranges from about 16°C in winter to 35°C in summer. On some hilly regions higher than 1600 mètres above sea level the temperature drops to below 5°C in winter and never rises higher than 25°C in summer. Rainfall varies greatly in different parts of the country. There are small areas in the south peninsula of the island where an annual precipitation over 2000 mm occurs. Large areas of the country receive 1000-1500 mm of annual rainfall, while in some districts, this is less than 500 mm. The water supply for fish culture in ponds should be adequate.

The selection of a fish for pond culture on a commercial scale is based on the following criteria:

1) The fish should be either herbivorous or omnivorous in feeding habit;
2) It should be fast growing;
3) Its fry should be easily obtainable.

In accordance with these points the following species have been suggested:

1. The yellow-tailed fresh water mullet, *Agonostomus monticola* (Bancroft) is abundant in practically all the streams of Haiti. It is omnivorous eating algae and other food. Beebe and Tee-Van (1928) found seeds, berries, insects and mites in stomachs of three fishes examined. In an aquarium the writer found it eating cereals, dried shrimp powder and cornmeal. Large specimens will swallow small fishes and snails. A. J. Thomas, fisheries officer of Jamaica, states that it grows to about four pounds in reservoirs (personal communication). However, its growth rate and spawning habits are not known and its life history should be thoroughly investigated before the species can be claimed to be profitable for pond culture. Small ponds of both running and stagnant water types should be built for experiments.

2. The common carp, *Cyprinus carpio* Linn. is the hardiest and most easily propagated fish at the present time. It can be acclimatized to all regions, although it thrives best in the temperate zones. It is cultivated with great success throughout the world in ponds and rice fields. For these reasons the introduction of this fish in Haiti appears to be justified. Not only could the carp significantly increase the productivity of the streams, lakes and rivers of Haiti, but also the useful poeciliids and the fresh water mullet, which is now considered desirable for propagation in ponds, would not be affected by the introduction, since they do not thrive in the same habitat. The mullet thrives only in the rapid clear water mountain streams, while the common carp requires deep slow-moving or stagnant water with luxuriant vegetation. The poeciliids thrive in shallows and on the surface.

Carp living in the rivers and lakes are practically all scaled and rather long in form. Scaleless types e.g., the leather and mirror carp, are bred for pond culture. In recent centuries fish culturists in central Europe, especially Germany, have been able to breed certain variety of leather and mirror carp which grow extremely fast and supply excellent meat for the table. The fatbellied carp of South China are very hardy and spawn readily in captivity in a subtropical to tropical climate. They have been successfully introduced and propagated in Indo-China, Thailand (Siam) Malaya and Indonesia. The drawback to using this variety is that it does not grow very fast, the maximum rate being 1-1½ lb in two years or more.

The mixed variety of the "German carp" which were introduced to the United States, Japan, Ceylon, India and Palestine do not spawn so readily in these waters but grow very fast, especially in warm waters where the temperature remains above 20°C the year round. A fish culturist in Madras, India reports that he found a 2-year old carp weighing 4 kg. The Japanese fish farmers usually

obtain carp of 2 years old weighing 2½ kg even from congested ponds. This explains the high yield of the common carp ponds in Japan and Palestine where the harvest comes over 2 tons per hectare with the application of artificial feeding. Japanese fish farmers have managed to produce over 100 kg of carp per sq. m. in a small running water pond with heavy artificial feeding within a period of 7 months. It was considered worthwhile to try the rearing of the German carp in Haiti for profit.

3. Sepat Siam, *Trichogaster pectoralis* (Regan), has proved to be one of the most successful species for "rough release" in rice fields and lakes and irrigation canals in Malaya and the Celebes. It is extremely prolific. The yield has reached more than a metric ton per hectare per annum. As the rice fields and the lowlands of Haiti are flooded for several months in very much the same manner as in Malaya and the Celebes, the introduction of Sepat Siam would be beneficial to the farmers living in these areas.

4. *Tilapia mossambica* Peters, was first introduced into St-Lucia, British West Indies, from Malaya in 1950. In the same year about 400 of them were shipped by air from St-Lucia to Jamaica where they established themselves and thrived.

Although Tilapia does not grow rapidly to a large size in fresh water, it is easily handled by fish farmers who have no previous experience with fish culture. The advantage lies in its hardiness, extremely prolific nature and readiness to take many kinds of oil meals and cereal brans. Being a mosquito larva destroyer, it grows particularly well in rice field, ditches and irrigation canals.

Mr. Soong Min Kong, the Fisheries Research Officer of Federal Malaya and Singapore reports that *Tilapia mossambica* grows to a length of 22 cm and to a weight of 150 grams in fresh waters. In brackish water they do much better, growing up to 900 grams each. D. Hey in his book *"The culture of freshwater fish in South Africa"* mentions that this fish grows to 5 lbs in South Africa, with the average in the vicinity of 2½ lbs. Productivity of *Tilapia mossambica* is about 1000 kg per hectare per annum in brackish water with no additional feeding. In fresh water the same result is obtained with additional feeding of rice bran. Similar results were observed in Jamaica.

5. The Cichlid, *Chichlosoma haitiensis* (Tee-Van) is found to be a dominant species in most rivers and lakes where the water is more or less stagnant or slow moving. It is a hardy species and omnivorous in feeding habit, but grows slowly, making it less desirable for pond culture.

6. The Sea Mullet, *Mugil curema* (Cuvier and Valenciennes) is abundant in brackish water tidal streams, rivers mouths and inshore waters. When brackish water ponds are built it should be the major fish to be reared there. The life history of this fish is in need of immediate study.

On the basis of the above observations, a 5-year working scheme was drawn and submitted to the Government of Haiti by FAO and was accepted. A budget of 50,000 gourdes or 10,000 U.S. dollars was provided by the Government for the fiscal year 1950-51 to cover the cost of pond construction, introduction of fishes and other local expenses and the FAO Technical Assistance programme provided the salary, allowances, and travelling expenses outside Haiti for the technical expert. Under such cooperative fiscal arrangements the actual work of pond construction started at the end of November 1950.

In the fish culture project three stages of development are visualized. The first is to establish a fish fry nursery with a few experimental ponds for propagating the exotic domesticated fishes as well as indigenous species. When a stock of fish fry is assured and ready for distribution the next step will be the

building of demonstration and extension centres in suitable localities in the country. Lastly, marketing and utilization of the fish produced in ponds must be seriously considered for any incentive to produce more fish can come only from the farmer's confidence that his effort will be rewarded.

In the first two years of the fish culture scheme, therefore, work is to be concentrated on the construction of nursery and experimental ponds and on the introduction of exotic fishes. In November, 1950 selection of sites for two small nurseries and plans for pond construction were begun. Mr. Leonce Bonnefil and Mr. Emanuel Garnier were authorized by their Government to carry out the work.

Through the preliminary survey carried out in June to August, 1950, the yellow-tailed fresh water mullet, *Agonostomus monticola* (Bancroft) was found to possess certain characteristics which are desirable for culture in ponds. Although the source of its fry is still unknown it was considered to be worth while to construct some type of experimental running water ponds for cultivation of this mullet. The conditions of the pond would be as similar to the natural habitat of the fish as possible. For this purpose a small area of 600 sq. m. immediately above 6 hectares of the rice fields in Mariani was selected, where constant water supply from a spring can be obtained all the year. On the same grounds small ponds are to be built for breeding of *Trichogaster pectoralis* or *Tilapia mossambica.*

Meanwhile, carp culture in ponds as well as in rice fields was planned. A piece of land 1.7 hectares in area in the Damien agriculture farm was selected for use as a carp nursery and experimental centre. The place is wooded with cocoa-nut trees and is adequately irrigated by two canals, one leading water from a stream and the other from an underground water pumping station of the farm.

Work on the construction of simple ponds was started late in November, 1950. By the end of April 1951, 7 ponds were completed. The 7 ponds are of the following dimensions:

In Mariani:		In Damien:	
Pond A	10m x 15m x 1m	Pond S 1	15m x 20m x 70cm
Pond B	16m x 15m x 1m	Pond S 2	14.5m x 20m x 70cm
Pond C	8.3m x 13.6m x 80cm	Pond L 1	27m x 51m x 90cm
		Pond L 2	35m x 50m x 60cm

Mariani lies in a small valley on the steep side close to the southern shore of the Port-au-Prince Bay. The ground of this district is covered with a thick layer of conglomerating calcareous pebbles, gravels and sand. The top soil is not deep in this area. When ponds are built on such ground they are not likely to hold water well unless a layer of mud or clay of 20 cm or more thick is placed on the bottom. A layer of mud should also be added to the inside of the embankments. The following steps have proved to be effective in improving the impermeability of the 3 ponds in Mariani: the bottom is levelled and packed with heavy rollers or rammers; mud or clay is added to at least 1 cm in thickness; the pond is filled with water; cattle are driven in or labourers are employed to paddle in the pond while water is kept flowing in to fill the interspaces between the pebbles and gravel with mud or clay.

The ground in Damien is covered with a layer of fine calcareous sand or sandy loam of considerable depth, which consists mainly of broken pieces of coral and shells. The ponds constructed in this area are found to hold water much better than those in Mariani, although the loss of water through seepage

still amounts around 5 cm in 24 hours. This water is replaced two or three times a week from the irrigation canals. The permeability is expected to be reduced in time as more silt is precipated to the bottom.

It was planned to build 4 more ponds before the end of this fiscal year for rearing of fry and adult fish, but as excavation work is difficult and uneconomical during the rainy season, which extends from April to October in Port-au-Prince area, further pond construction had to be postponed until November.

Attempts have been made to procure a supply of *Trichogaster pectoralis* from a few sources for breeding and feeding experiments but so far they are not successful.

Tilapia mossambica was introduced to Jamaica, British West Indies in 1950 where it multiplies and establishes itself. The Fisheries Officer of Jamaica sent a supply of 113 *Tilapia* to Haiti in June, 1951.

Through the arrangement of Dr. Stillman Wright of U.S. Fish and Wildlife Service, a shipment of 123 carp fingerlings was received from Mr. Jack Snow, fish culturist of U. S. Marion Fish culture Station, Alabama on February 22, 1951. The fish arrived here in perfect condition. Their measurements were recorded as follows:

Size	Length	Weight
Average	17cm	72 grams
Smallest	15cm	57 grams
Largest	20cm	90 grams

These fingerlings, from the spawn of April or May, 1950 in the experimental ponds of the Marion Station, belong to the high-bodied, scaled carp said to be of German origin. Again in September 12, another shipment of 300 carp fingerlings was received with the help of Mr. H. S. Swingle of the Alabama Polytechnic Institute.

The mild tropical climate in Haiti is favourable for the growth of carp. In about 5 months each of the 23 carp in a pond grew on the average from 160 to 2040 grams gaining 1880 grams in weight as shown in the following table:

Date	4-5-51	18-8-51	8-10-51
Average length (cm)	23	45	52
Average weight (gr)	160	1360	2040

The smallest carp examined in October 8, 1951 weighed 1810 grams and the largest 2260 grams.

The 103 Tilapia introduced from Jamaica on June 22, 1951 grew from 4 cm to 18 cm, weighing about 80 grams each in 2 months. Meanwhile they multiplied by hundreds at the end of August.

At the present stage of development of the project it is too early to ascertain the productivity of ponds in Haiti, but preliminary observations indicate that high yield of ponds could be expected through association of species, artificial feeding, application of fertilizers, regulaton of water supply, proper harvesting etc. A small pond of approximately 100 sq. m. in area in Mariani, for example has yielded 13 kg of fish and shrimp in 4 months rearing, or 3915 kg per hectare per annum. Another pond of about 320 sq. m. in Damien produced 38.16 kg. of carp alone in a period of 5½ months, or 2600 kg per ha per annum.

For the practice of combination of species in ponds built in the plain valleys and swamp areas near the sea, the preliminary experiments show that

the following kinds of fishes and crustacea would become of considerable importance.

The freshwater mullet, *Agonostomus monticola* (Bancroft), the gobies, *Dormitator maculatus* (Bloch), *Electris pisonis* (Gmelin), *Awaous taiasius* (Lichtenstein), *Evorthodus lyricus* (Girard); the short rostrum Shrimp, *Macrobrachium carcinus* (Linn.), the long rostrum shrimp, *Macrobrachium acanthurus* (Wiegmann).

A number of people were impressed by the rapid growth of carp and Tilapia in the experimental ponds and have asked for advice in building ponds. Steps are being taken to supply fish fingerlings from the nursery when their ponds are ready for stocking.

An experiment was started on May 21 to find out whether the *Gambusia* and *Limia* will thrive as usual in the carp ponds. Over 100 *Gambusia* and *Limia* were put into a pond with 23 carp. A few hundred more were also placed in other ponds and the canal in Damien. Meanwhile hundreds of young Poeciliids were observed in the drainage canal. The water in the canal is clear with good growth of *Spirogyra*. The poeciliids introduced into the ponds appear to live very well. They were seen swimming under the shade of the coconut tree near the shore, and at the end of two months after introduction thousands of poeciliids, mostly young ones, were observed in all the ponds in Damien. No mosquito larvae were observed in any of the ponds.

In order to train local staff to follow up the project and extend fish ponds to the whole country after the FAO expert leaves, two fellowships on fish culture were provided by the FAO Technical Assistance Programme. These will enable Haitians to study abroad. The first Fellow went to the Far-East in September 1951 to study modern commercial fish farming on a large scale. The next Fellow will go abroad sometime in 1952, after the first has returned.

The writer has been deeply impressed and encouraged by the manner in which the Haitian government officials have cooperated in this project. The keen interest and efficiency expressed by the officers appointed by their Government to administer and direct the project have expedited the work and have made it possible to accomplish more than was expected.

Thanks are due to the U.S. Fish and Wildlife Service and the Fisheries Office, Jamaica, B. W. I. for the arrangements they made to send the carp fingerlings and the *Tilapia* fingerlings to Haiti. The cooperation given by the Service Cooperatif Inter-American de Production Agricole (SCIPA) in supplying machines to excavate the big ponds is acknowledged. To many friends, workers, and technical experts who have supplied data, information, comments and suggestions concerning the fish culture project the writer is indebted. Without the help and cooperation as mentioned above, the progress of the present fish culture project would be impossible.

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Sport Fishes of the Vicinity of the Gulf of Honduras, Certain Caribbean Islands, and Carmen, Mexico*

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GULF OF HONDURAS AND THE CARIBBEAN

PART I

A study of the fishes in the vicinity of the Gulf of Honduras was made in conjunction with an archeological survey of the region. The expedition was made in January and February, 1950, under the auspices of the Institution for Andean Research, Inc. The sport fishing possibilities of the area were explored, as there appears to be no published information on this subject. The survey was not made in the best fishing season and the party moved on so frequently that no one locality could be thoroughly investigated, but it is hoped that the information contained herein may be of some assistance to persons who have occasion to be in the areas studied and wish to try the sport fishing. This paper groups the facts discovered with the species of fish concerned, while a regional summary at the end of each part lists the species seen and also enumerates fish which were not seen but whose presence was reported by local people. While only the sport fish are discussed here, a collection including other local fishes was made for later study.

Mr. Charles S. Bird, Colonel John K. Howard and the archeologists Dr. Alfred V. Kidder, Dr. Gordon Eckholm and Mr. Gustav Stromsvik, as well as Captain Matthew English of the vessel "Irmay" and his crew, all contributed greatly to the success of the ichthyological work. Valuable assistance was also obtained from officials of the United Fruit Company and from Mr. R. K. Masson, Port Captain and Collector of Customs at Belize. Dr. Lionel A. Walford, Chief of the Branch of Fishery Biology, U. S. Fish and Wildlife Service directed the first ten days of intensive collecting, setting up procedures which were followed during the remainder of the trip.

There are scattered populations of tarpon (*Tarpon atlanticus*) in rivers and lagoons of the northwestern Caribbean. The Trujillo area was the only one on the coast of Honduras in which these fish were encountered. In the canal at Puerto Castilla, many strikes were obtained by trolling small spoons and two or three very small tarpon were landed. The fish striking appeared to range from three to twelve pounds, except for one which looked to be of nearly fifty pounds. Residents said that tarpon had frequented the steamer dock at Puerto Castilla when it was used by the fruit ships. Some of these fish were also seen in the entrance to the lagoon of Guaimoreto, where fishermen reported the

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they often caught them. Tarpon were said to be plentiful in various lagoons on Utila Island and there are probably other places on the coast of Honduras and among the Bay Islands where they occur.

The coast of Guatemala appears to offer greater possibilities for the tarpon fisherman than that of Honduras. Many tarpon were seen in the Rio Dulce between Livingston and the Golfete, but only three strikes were obtained. This river undoubtedly supports a large population of tarpon and it can be fished a great distance further inland. First hand information indicated that there is often excellent tarpon fishing in the Graciosa River or Hospital Bight, although no fish were seen on the single visit made there.

In British Honduras there are several places which offer good tarpon fishing. A "tarpon hole" near Frenchman's Cay was found with the assistance of native fishermen. Tarpon which were rolling in schools ignored trolled lures but struck at fresh water bass plugs of the swimming type when these were cast accurately among them. One fish of about forty pounds was hooked but parted the light line after running clear across the pool into the mangroves.

In the Manatee River there were times when small tarpon would hit the plug on almost every cast, if a snook or jack crevalle did not get it first. On these occasions, the fish were showing among the mangrove roots on the banks. Some large tarpon were raised by casting, but they more frequently struck lures trolled in mid-stream. The larger fish appeared to be more solitary in their habits than the smaller ones. The tarpon landed here weighed from four to eight pounds, but some of those lost appeared to weigh well over fifty pounds.

The Belize and Sibun Rivers were also said to afford good tarpon fishing. The lighthouse keeper at Cay Bokel directed the party to some creeks among the Turneffe Islands which he said were good tarpon waters, but only one strike was obtained in the short time fished.

At Grand Cayman, two of the party fished for tarpon in small, landlocked lagoons. Natives said that the fish came from the sea through subterranean passages. Many little tarpon were seen rising but they struck only half-heartedly at small plugs. A member of the party who remained on the island caught one by using a live minnow for bait. Natives reported that larger tarpon are caught in the shore waters.

Ten-pounders (*Elops saurus*) were reported to inhabit the entrance to the lagoon of Guaimoreto near Trujillo. Three were taken by plug casting in a school which surfaced at night around the boats in Belize Harbor, while others were caught or hooked on plugs and feather lures in the Manatee River. These will take swimming plugs. Those caught weighed about four pounds each.

The bonefish (*Albula vulpes*) inhabit many of the flats of the northwestern Caribbean. Some were caught in the beach net at Cape Honduras off Trujillo, and one was seen at Tela. Many schools of these fish were seen on a flat near the harbor entrance at Utila Island and natives reported that they were far more numerous in a cove on the north side. Others were observed on flats near Coxen Hole, on Roatan Island, and they were said to be plentiful on Guanacca Island. Soldier crabs (*Pagurus*) were the preferred bait for bonefish among the Bay Islands.

The waters of British Honduras evidently support a considerable population of bonefish. Several very small ones were seen in the live well of a fishing boat at Frenchman's Cay. Larger specimens, weighing from about three to six pounds, were for sale in the markets at Stann Creek and Belize. A few schools were seen on the flats near Cay Bokel Light. The keeper reported that bonefish had been very plentiful, but that the local population was now reduced in

numbers by seining. He recommended conch for bait and chum. No strikes were secured in the very short time spent fishing there but it is probable that the bonefish enthusiast could find plenty of these fish in this region.

The great barracuda (*Sphyraena barracuda*) was one of the most common reef fish in the northwestern Caribbean. In the Trujillo area the party did not fish the reefs, but took some of these fish in the entrance to the lagoon of Guaimoreto and in Trujillo Bay where they were said to frequent the steamer dock at Puerto Castilla. They were not caught at the other places fished along the coast of Honduras, most of which were sandy.

Among the Bay Islands barracuda were caught in greater numbers than any other species, taking almost any lure trolled near the reefs. These fish ranged from four to twelve pounds in weight. Some small ones were also taken in the vicinity of Puerto Barrios in Guatemala.

In British Honduras, numerous barracudas were caught along the barrier reef, off Cay Bokel and at Glover Reef, the largest weighing twenty-one pounds. Inside the barrier they were not so plentiful, but a few were taken in river mouths and around the inner reefs and cays. Several barracuda were boated in the short time spent fishing at the Swan Islands.

The barracuda took practically every type of lure voraciously, but a large spoon trolled on a wire line seemed the most attractive in the deeper waters.

Blackfin tuna (*Parathunnus atlanticus*) and false albacore (*Euthynnus alletteratus*) were found in the vicinity of the Gulf of Honduras.

Blackfin tuna of about 3 pounds were taken between Trujillo and Bonacca Island, and small schools of these fish were seen near the Hog Islands, while other schools which may have been of this species were observed near Tela and Puerto Cortes.

Larger schools of small blackfin tuna were found among the Bay Islands, but rod and reel fishing was made almost impossible by the sharks which shadowed the tuna and seized them as soon as the latter started struggling on the line. The blackfins often were shy and refused to strike, but on one occasion ten were taken on handlines in a half-hour with small feather lures and 6/0 hooks. A few solitary blackfin tuna and false albacore were caught by trolling along the reefs or banks. These fish ranged from about two to seven pounds in weight.

Off British Honduras, schooling blackfins were seen inshore of Glover Reef and the Turneffe Islands but none were caught. Some small false albacore were taken inside and along the outer reef of British Honduras. The lighthouse keeper at Cay Bokel reported that fish apparently of these species weighing up to twenty-five or thirty-five pounds had been taken in the vicinity. At Cozumel Island several schools of blackfin tuna were sighted and three fish of about twelve pounds each were caught. Most of the schools of blackfin tunas were found from two to five miles offshore and were between islands or islands and mainland.

The kingfish (*Scomberomorus cavalla*) and its relatives, the cero (*Scomberomorus regalis*) and the Spanish mackerel (*Scomberomorus maculatus*) were well represented in the northwestern Caribbean.

Cero and Spanish mackerel of about six pounds were caught off Cap Honduras and in Trujillo Bay and some larger ones were lost. Off the Mo tagua River, five kingfish, ranging from six to sixteen pounds in weigh were taken in two and a half hours. At Utila Island, one or two large kin fish struck at the marlin baits and one of about eight pounds was caught l trolling along the reefs. Five Spanish mackerel were taken in a gill net s in the harbor. The rip off Cape Tres Puntas in Guatemala provided go

kingfishing. Six ranging from five to fifteen pounds were taken with feather lures in about two hours of trolling.

Small cero and Spanish mackerel were abundant among the inside reefs of British Honduras and some small kingfish were also caught there. Larger cero and kingfish were taken by trolling off the outer reefs, and the lighthouse keeper at Cay Bokel said that there was a fine run of large kingfish there in the spring. Natives of Grand Cayman said that large kingfish were taken by trolling with sprats (*Sardinella sardina*) from sailing canoes and constitute an important commercial catch for the island.

No wahoo (*Acanthocybium solandri*) were caught in the vicinity of the Gulf of Honduras, but it was reported that they were occasionally taken in the offshore waters. The Hog Islands and the waters off Belize were reported to be good grounds for these fish, the best season at the latter place being in the spring and early summer.

A seven pound wahoo was caught from the "Irmay" off Grand Cayman. Natives there said that these fish, locally called "queenfish," are caught regularly and reach weights of eighty pounds or more. They attributed the poor fishing at the time of our visit to the long duration of fresh easterly winds. At the Swan Islands these fine fish appear to be relatively abundant. An eleven pounder was caught from the "Irmay" as she approached the island, while what appeared to be a much larger one was hooked at the same time on another line but got away and soon after this a heavy handline was parted. The next morning four wahoo were hooked simultaneously and three were boated. The two largest weighed fifty-seven and thirty-six pounds respectively, while the third was only slightly smaller. Another heavy handline was parted as the party left the islands. It was unfortunate that more time could not be devoted to exploring the possibilities of these islands and that a more suitable fishing boat was not available. The wahoo took white, yellow, and red and white feathers at speeds of four to nine knots.

Blue marlin (*Makaira nigricans ampla*) and sailfish (*Istiophorus americanus*) were reported in the Gulf of Honduras region, but most of our information on these fish was obtained from local fishermen. As they make no attempt to catch these species, they are not as well acquainted with them as with the fish they catch commercially. No estimates of their abundance could be made, except that they did not appear to be plentiful in midwinter.

Trujillo was the only locality on the coast of Honduras where we found convincing evidence of the presence of billfish. An employee of the United Fruit Company has caught a sailfish and lost a marlin off Cape Honduras. Residents at Puerto Castilla had observed sailfish in Trujillo Bay and reported one which they had seen speared from the town dock. Trolling with outrigger baits in the Bay and off Cape Honduras was unproductive, but the time spent was not nearly sufficient to test the possibilities of the place. The baits were not molested by other species of fish

The Bay Islands appear to be a better fishing ground, especially for large marlin. The only certain billfish strikes were obtained about a mile or two north of Conical Hill on Utila Island. A fish believed to be a blue marlin of about 300 pounds was hooked and parted the 24-thread line after making a considerable run and two or three leaps. On the next day, a fish thought to be a white marlin (*Makaira albida*) struck, but threw the hook on its first jump. Both struck at large mullets, a bait which was rarely obtainable. On both days other strikes were obtained which might have been from billfish. About twenty hours were spent in offshore trolling at Utila and five hours

at Bonacca. Off Utila smaller fish, especially barracudas, often spoiled the outrigger baits, making it virtually useless to troll them near any bank or reef and at Bonacca large quantities of floating weed continually fouled the lures.

Bay Island fishermen related many stories about marlin and showed us the bill of a sailfish they had taken. They told of a U. S. sportsman who had hooked five large blue marlin in one week fishing off Bonacca Island, but had lost all of them. They did not recall what time of year this occurred and there seemed to be no agreement as to which season was the best for this fishing.

Fishermen in British Honduras report sailfish, which they call "ocean pipers," and marlin along the barrier and outlying reefs. Among the favored localities are Columbus Reef, English Cay, Cay Bokel and Glover Reef. The lighthouse keeper at Cay Bokel said that he frequently observed sailfish, sometimes three or four at a time and also saw a very large marlin caught by handline. No billfish were raised in about twenty-five hours of trolling in these localities and off the Zapotilla Cays. The latter is an excellent looking ground with fine rips, but fishing was hampered by excessive amounts of floating weed. The best season for marlin and sailfish in British Honduras was said to be in the spring and early summer.

Natives reported large marlin, locally called spikefish, off Grand Cayman Island and sailfish off the Swan Islands and Cozumel Island, but little specific information was obtained.

Jacks were among the most common fish in many of the localities visited. In the Trujillo area, the jack crevalle (*Caranx hippos*) was very abundant. Eight, ranging from two to twelve pounds, were taken in an hour and a half of trolling off Cape Honduras. Some were also caught in the channel to the lagoon of Guaimoreto and off the mouth of a small river west of Trujillo. Off the Motagua River, twelve of these fish were boated in two and a half hours, although the very effective wire line was used only for the first few minutes. A blue runner or hardtail (*Caranx crysos*) was also taken at this place.

Among the Bay Islands jacks were not so plentiful. A large yellow jack (*Caranx bartholomaei*) was taken off Utila. Horse-eye jack (*Caranx latus*) and brown jack (*Caranx ruber*) were taken in the harbor and lagoons of this island. A brown jack and a rainbow runner (*Elagatis bipinnulatus*) were caught off the reefs of Barburata, near Roatan Island.

Off the coast of Guatemala blue runners were the only jacks taken but they were very numerous. Some were caught at Ox Tongue Light, where schools of them were seen surfacing in the rips, while others were taken off Cape Tres Puntas and en route to Punta Gorda.

In British Honduras, jack crevalles were numerous in the rivers and many were taken by plug casting or trolling in the Manatee. Some yellow jack were caught by trolling off the inner reefs and cays.

A six pound rainbow runner was taken off the Swan Islands, and a twenty six pound amberjack (*Seriola dumerili*) was caught off Cozumel Island.

Jack crevalle struck freely at almost any lure, but in water of sufficient depth a spoon trolled on a wire line was extremely effective and in rivers we had good luck with plugs. Most of the other jacks were caught on trolled feather lures. Fifteen thread tackle was usually used for trolling, but better sport would be had with lighter gear. The jack crevalles and yellow jacks take

weighed from two to about fifteen pounds, while most of the brown and horse-eye jacks and blue runners weighed less than three pounds.

Dolphin (*Coryphaena hippurus*) were found occasionally in the northwest Caribbean. Although none were encountered along the coast of Honduras and Guatemala, four were caught in three hours of fishing off Conical Hill, Utila Island, and two were boated while trolling along the rips off the Zapotilla Cays. One was caught at the Swan Islands and two at Cozumel Island, where they were also seen leaping in spectacular pursuit of flying fish. Those caught weighed from eight to eighteen pounds each and were taken on heavy handlines or 15-thread rigs, but 9 or 6-thread tackle would be more sporting. They took strip baits trolled at five knots and feather lures trolled similarly or when cruising at nine knots.

The snook (*Centropomus undecimalis*) is plentiful in the rivers of Guatemala and British Honduras. None were taken in Honduras or the Bay Islands but little fishing was done there in waters suitable for these fish. It is probable that they could be found in some of the lagoons and rivers of these regions.

At Livingston, Guatemala, in the mouth of the Rio Dulce, there is a commercial fishery for snook. They are shipped to Guatemala City where they are a favorite table fish. The director of this fishery said that three hundred snook had been caught in the early morning of the day the party made a trip up the Dulce. On the next morning, the "Black Prince" was fishing the harbor along with forty-five native canoes but no catches were observed. The captain of the fishing cruiser operated by the United Fruit Company reported taking very large catches of snook far up the river. Two snook, weighing three and six pounds respectively, were caught by trolling small spoons off the mouth of the Graciosa River where a Guatemalan sportsman reported taking them in considerable numbers.

In British Honduras, excellent snook fishing was found in the Manatee River where these fish were often seen surfacing among the mangrove roots, grouped with small tarpon and jack crevalles. Almost every cast with a fresh water bass plug would secure a strike from one of these species and they also hit spoons or feathers, either cast or trolled. In one day eight snook weighing from about four to twelve pounds were taken, although much of the time was spent trolling for large tarpon in mid-stream, and playing large jacks on light tackle. Snook could usually be caught, even if they were not showing, by casting or trolling close to the banks. It is probable that they are equally plentiful in other rivers of British Honduras. Fresh water plug casting rigs are ideal for this fishing.

Groupers are an important food fish in the northwestern Caribbean. None were taken along the coast of Honduras, but they were fairly numerous among the Bay Islands. A 35 pound black grouper (*Mycteroperca bonaci*)* was boated after making a leaping strike at a marlin bait off Utila Island. Commercial catches at Utila also included yellow groupers (*M. venenosa*)* and Nassau groupers (*Epinephelus striatus*), weighing less than seven pounds each. Some four or five pound tiger rockfish (*M. tigris*)* were taken by deep trolling with a large spoon on a wire line off Bonacca and Roatan Islands. A small spotted jewfish (*Promicrops itaiara*)* was caught on a small spoon trolled near the entrance of the Graciosa River in Guatemala.

The barrier and outlying reefs of British Honduras produced a good many black and yellowfin groupers. Almost all of these were taken by deep trolling

*Tentative identification

along the outside of the reefs with a large spoon on the wire line, and they ranged from 8 to 26 pounds in weight. Cay Bokel in the Turneffe Islands offered the most consistent fishing for these species. Nassau groupers were also caught occasionally in the waters of this colony.

Snappers also form an important part of the commercial catch in the northwest Caribbean. On the coast of Honduras we encountered the grey snapper (*Lutianus griseus*) the school-master (*L. apodus*)*, the muttonfish (*L. analis*) and the black snapper (*L. cyanopterus*). A thirty-eight pound specimen of the last species was caught on a trolled surface plug in the inlet to the lagoon of Guaimoreto.

Among the Bay Islands, some yellowtails (*Ocyurus chrysurus*) were taken by trolling feather lures, and schoolmasters and muttonfish were seen among the commercial landings. Handliners fishing in deep water took some vermilion snappers (*Rhomboplites aurorubens*)*, a fish called "salmon" (*Etelis oculatus*)* and red snappers of a species not determined.

In the waters of British Honduras, some muttonfish, yellowtails, and a dog snapper (*Lutianus jocu*)* were taken among the reefs and cays, and a 30 pound black snapper was caught on a trolled swimming plug in the Belize River. Lane snappers (*Lutianus synagris*) were occasionally seen among commercial catches.

Part II. Vicinity of Carmen, Campeche, Mexico

A survey of the sport fishes in the vicinity of Carmen, Mexico, on the Gulf of Campeche, was made from March 6 to March 26, 1950. The party comprised Col. John K. Howard, of the Harvard Museum of Comparative Zoology, Dr. Raymond A. Gilmore of the U. S. Fish and Wildlife Service, and the author, representing the Woods Hole Oceanographic Institution. While there the party collected many species of the local fish fauna for future study.

Most of the sport fishing was done with rod and reel from a boat chartered from Senor Miguel A. Manjarrez, the local representative of the Department of Fisheries of the Mexican government, who also provided a large beach seine. While only two hauls were made with this gear, one of them, made in a small lagoon at the northwest corner of Carmen Island, was very successful. Thanks are extended to Don Pedro Palazuelos who invited the party to spend a day on one of his shrimp boats and select specimens from the catch. He also presented the party with a collection of fish from another of his boats and furnished much other assistance. Gratitude is also expressed to Mr. Lewis Frank for donating working space in his shrimp processing plant, and to Mr. Torquato Paz of La Aguada, who was most helpful in arranging purchases from local fishermen and in guiding the party.

There follows a description of the sport fishing possibilities for the various species which were encountered at the time of the sojourn. Other game fishes which were seen in the markets or reported by residents are included in a list at the end of the paper. Fish which are of no sporting interest have been omitted.

Carmen is becoming famous for its tarpon fishing. These fish appeared to be extremely numerous in this area, although their average size may not be as great as in some other well known tarpon grounds.

The many rivers and passes in the Laguna de Terminos offer a wide choice

*Tentative identification

Common Name	Scientific Name	Coast of Honduras		Bay Islands		Guatemala		British Honduras		Grand Cayman Island		Swan Islands		Cozumel Island	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Amberjack	*Seriola dumerili*														
Arnillo	*Apsilus dentatus**			x										x	
Barracuda	*Sphyraena barracuda*	x		x		x		x				x			
B'ack grouper	*Mycteroperca bonaci**			x				x							
B'ack snapper	*Lutjanus cyanopterus*	x						x							
B'ackfin tuna	*Parathunnus atlanticus*	x		x				x							
Blue marlin	*Makaira nigricans ampla*		x	x					x		x			x	
Blue runner	*Caranx crysos*	x				x									
Bonefish	*Albula vulpes*	x		x				x							
Brown jack	*Caranx ruber*	x		x											
Cachuco	*Etelis oculatus**			x											
Cero	*Scomberomorus regalis*	x						x						x	
Croaker	*Micropogon sp.*							x							
Dog Snapper	*Lutjanus jocu**							x							
Dolphin	*Coryphaena hippurus*			x				x				x		x	
False albacore	*Euthynnus alletteratus*	x		x				x							
Grey snapper	*Lutjanus griseus*	x													
Hogfish	*Lachnolaimus maximus*			x											
Horse-eye jack	*Caranx latus*	x		x				x							
Jack crevalle	*Caranx hippos*	x						x							
Jolt head porgy	*Calamus bajonado**							x							
Kingfish	*Scomberomorus cavalla*	x		x		x		x			x				
Lane snapper	*Lutjanus synagris*							x							
Mako shark	*Isurus oxyrinchus*								x						

* Tentative Identification
1 Taken or seen
2 Reported but not seen

Common Name	Scientific Name	Coast of Honduras		Bay Islands		Guatemala		British Honduras		Grand Cayman Island		Swan Islands		Cozumel Island	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Margate fish	*Haemulon album*								x						
Muttonfish	*Lutjanus analis*	x		x				x							
Nassau grouper	*Epinephelus striatus*			x				x							
Permit	*Trachinotus goodei*			x											
Rainbow runner	*Elagatis bipinnulatus*			x					x			x			
Red hind	*Petrometopon cruentatus*			x				x							
Red snapper	*Lutjanus sp.*			x											
Reef jack	*Seriola falcata*			x											
Round pompano	*Trachinotus falcatus*							x							
Sailfish	*Istiophorus americanus*		x		x				x				x		x
Schoolmaster	*Lutjanus apodus**	x		x											
Spanish mackerel	*Scomberomorus maculatus*	x		x				x							
Snook	*Centropomus undecimalis*		x		x	x		x							
Spotted jewfish	*Promicrops itaiara*					x		x							
Tarpon	*Tarpon atlanticus*	x			x	x		x		x					
Ten-pounder	*Elops saurus*		x					x							
Tiger rockfish	*Mycteroperca tigris**			x											
Vermillion snapper	*Rhomboplites aurorubens**			x											
Wahoo	*Acanthocybium solandri*		x		x				x	x		x			
White marlin	*Makaira albida*			x											
Yellow jack	*Caranx bartholomaei*			x				x							
Yellowfin grouper	*Mycteroperca venenosa**			x				x							
Yellowtail	*Ocyurus chrysurus*			x				x							

* Tentative Identification
1 Seen or taken
2 Reported but not seen

fishing spots to the tarpon enthusiast. Among the most popular is the astern Entrance or Barra Aguada, which at times is full of schools of rfacing tarpon (*Tarpon atlanticus*). The party took several fish there rang- g from twenty to fifty pounds, by trolling, and no larger ones were seen. Larger tarpon were found in the arm of the lagoon east of Aguada leading Sabancuy. One fish weighing slightly over fifty pounds was boated and veral which looked larger were lost.

Another excellent tarpon ground is on the Candelaria River at Polvoshal anch. The party trolled there for only about an hour, but fish were rising d striking steadily and two, weighing twenty-five and forty pounds res- ctively, were caught. Another party of fishermen reported catching about enty tarpon in one day at this place and these were also of a medium size.

The best tarpon fishing found in the western part of the lagoon was at oca Chica, a narrow passage which connects a small lagoon fed by two rge rivers with the main one. Tarpon in the main channel appeared to run om twenty-five to over a hundred pounds. A smaller channel was frequently ll of little tarpon near its entrance to the main passage.

The tarpon ground nearest to the city of Carmen is at the northwest corner Carmen Island. When tide and wind are proper, a fine rip makes up. One y some very large tarpon were seen leaping and two of them struck at ugs cast from the beach for snook. On the next day smaller fish were owing and five strikes were secured in quick succession by trolling among em. On other days there was no sign of fish. Undoubtedly many other rpon habitats could be found by anglers with a suitable boat and sufficient ne.

Most of the fish taken trolling were caught on feathers, yellow ones parently being preferred, but they also struck well on spoons. While only ificial lures were used, other anglers used small fish successfully as trolling its.

Tarpon struck well at casting lures, especially Pikie Minnows and Husky ies. The silver flash color or white and silver with red head were very ective, and the blue mullet scale was also good.

Barracuda (*Sphyraena barracuda*) are not as plentiful in the vicinity of rmen as in the Caribbean and among the Bahamas. Some inhabit the reef the west side of the Eastern Entrance of the Laguna de Terminos and entrance to the arm of the lagoon leading to Sabancuy. In the shallow ters of the latter place a thirty pounder put up a spectacular fight when en on a light rod with 9 thread line. The barracudas caught here averaged but twenty pounds in weight. One weighing fifty-five pounds was reported to e been caught while the party was at Carmen.

The barracuda took feather lures rigged as for tarpon with 9/0 O'Shaugh- sy hooks. The outfits used were 15 thread and 9 thread, the latter, of rse, being more sporting.

A few Spanish mackerel (*Scomberomorus maculatus*) were caught in the nity of Carmen on trolled feather lures. These ranged from two to six nds in weight, as did the few seen in the market. There was no indica- n that these fish were abundant at the time of this survey.

ack crevalle (*Caranx hippos*) were extremely abundant in the Carmen rn. About twenty of these fish, averaging fifteen pounds in weight, were ght from a shrimp boat by trolling and by throwing a baited hook bigside from the stern. In the latter case, the jacks would dart out from er the boat and seize the bait as it sank by the stern. Small fish caught

in the shrimp nets were used for bait, and the big jacks could be seen following the nets to the surface and feeding on escaping or discarded fish and crustacea.

Schools of these fish were observed in rivers and inlets, especially at tide rips. They struck trolled feather lures and spoons, usually being caught on tarpon tackle although they would provide better sport on lighter gear.

The only other jacks observed were blue runners, (*Caranx crysos*) which occasionally appeared in small numbers in the market.

Good snook fishing was found in the rip at the northwest corner of Carmen Island. One of the party took nine of these fish, ranging from four to twelve pounds, in one hour of casting from the beach into this rip. A regular fresh water plug casting rig with eighteen pound test line and a silver flash Pikie Minnow proved to be an effective and very sporty means of taking these leaping fighters. About a bushel of small snook (*Centropomus undecimalis*) was taken in a beach seine haul in the small lagoon nearby, and one was caught by plug casting at its inlet. Residents of Carmen catch a few snook from the docks at night, using handlines with shrimp for bait and chum.

Spotted jewfish (*Promicrops itaiara*) are fairly common in the region. One weighing about twelve pounds was taken in the arm of the lagoon leading to Sabancuy, and the capture of a hundred pounder by a native fisherman was witnessed at Boca Chica. Much larger ones are reportedly taken. Two small red groupers (*Epinephelus morio*) were caught by bottom fishing in the Gulf off Santa Rosa. Few groupers were seen in the market.

The black snapper (*Lutjanus cyanopterus*) is of interest to sport fishermen mainly because of its large size and willingness to take trolling lures. A thirteen pounder was caught on a feather lure in the Eastern Entrance, and a Texas sportsman donated to the collection a sixty-eight pounder taken there on the same day. The capture of a sixty-four pounder in the Candelaria River was also reported. Other species of snappers are taken by native fishermen including the muttonfish (*Lutianus analis*), the grey snapper (*L. griseus*) the lane snapper (*L. synagris*) and the red snapper called guachinango, which is the most highly prized.

About half a bushel of spotted weakfish (*Cynoscion nebulosus*), up to fou

CAMPECHE, MEXICO — Fish taken or seen

Common Name	Local Name	Scientific Name
Barracuda	Picuda	*Sphyraena barracuda*
Black drum	Tambor	*Pogonias cromis*
Black snapper	Pargo mulato	*Lutjanus cyanopterus*
Blue runner	Cojinua	*Caranx crysos*
Croaker	Roncador	*Micropogon sp.*
Grey snapper	Pargo mulato	*Lutjanus griseus*
Jack crevalle	Jurel	*Caranx hippos*
King whiting		*Menticirrhus americanus**
Lane snapper		*Lutjanus synagris*
Muttonfish	Pargo rubia	*Lutjanus analis*
Red grouper	Mero	*Epinephelus morio*
Red snapper	Guachinango	*Lutjanus sp.*
Round pompano		*Trachinotus falcatus*
Sand squeteague		*Cynoscion arenarius**
Snook	Robalo	*Centropomus undecimalis*
Spanish mackerel	Macarel	*Scomberomorus maculatus*
Spotted jewfish	Cherna	*Promicrops itaiara*
Spotted weakfish		*Cynoscion nebulosus*
Tarpon	Sabalo	*Tarpon atlanticus*
Triple-tail		*Lobotes surinamensis*
	Reported but not seen	
Ten-pounder	Macabi	*Elops saurus*

pounds in weight, was taken in a beach seine haul in the small lagoon on the northwest corner of Carmen Island. Mr. Cecil Branson of Carmen reported that they also frequented a cove on the south side of the island. Some smaller sand squeteague (*Cynoscion arenarius*)* were caught in the nets of the shrimp boats, as well as small croakers (*Micropogon*) of various species some of which were also caught in the beach seine. A few king whiting (*Menticirrhus americanus*)* weighing less than two pounds were also taken by the shrimp boats.

* Tentative identification

Early Explorations in the Gulf of Mexico

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History of early explorations in the Gulf of Mexico has a particular appeal to the persons engaged in the present studies of the oceanography and biology of this body of water. Thrilling descriptions of the adventures of the earlier explorers not only contain the records of their accomplishments and frequent failures but provide also an understanding of the personalities of the principal actors of the New World drama. From the yellowish and musty pages of the old books and maps arise live human beings who, poorly equipped but with great courage and determination, went to explore the unknown lands beyond the vast expanse of the western ocean. Their characters and the motives behind their heroic actions become understandable; and one is tempted to compare their lives and the conditions under which they labored with the present situations of scientists engaged in a study of problems of grave national importance.

Political and economic rivalry mong the countries of western Europe during the sixteenth and seventeenth centuries was so acute that their successful penetration into the wilderness of the New World, establishment of colonies, and access to gold, silver, and other riches of the new continent had profound effects on their destinies.

The beginning of the explorations in which the adventurers of Spain, Portugal, France, and England competed and frequently fought with each other for the possession of new territories can be formally dated back to the first voyage of Columbus.

The existence of the large sea called, at present, the Gulf of Mexico was known, however, to the natives long before the white man set foot on the newly discovered land. Aztecs of Mexico and natives of Yucatan were able to sail considerable distances from the mainland. Some of them mastered the art of map making to a fairly high degree of perfection. It is known, for instance, that in 1520 Montezuma presented Cortez with a map painted on a henequin cloth in which were marked rivers and bays of the northern coast of the Gulf from Panuco to Tobasco, a distance of about 140 leagues. In July 1502, sailing south from Cuba toward Honduras parallel to the eastern coast of Yucatan, Columbus encountered an Indian vessel of the size of a Spanish galley with 25 men in her crew. The ship, laden with various goods and products, was sighted 150 nautical miles from the coast of Cuba and about 79 miles off the Yucatan coast. Had Columbus followed the Indian ship he would soon have discovered the Yucatan and found the route to

Mexico. He sailed south and east, however, believing that this course would lead him to Cathay, the name by which China was known to medieval Europe.

The first discoverer of the Gulf of Mexico cannot be positively named, since the records of the early European explorations in the Gulf are confusing and frequently contradictory. The year of the European explorations in the Gulf naturally begins with the voyages of Columbus. In June 1494, during his second voyage, Columbus followed the southern shores of Cuba as far as Isla de Pinos and, disregarding the information received from the Indians that the end of the island was not far, he decided that Cuba was not an Island but a part of a continent and sailed eastward. In this way, his opportunity of discovering the Gulf was lost.

First claim for sailing along the southern and eastern coasts of the new continent for a distance of 870 leagues (probably as far north as Cape Hatteras) was made by the man whose name is forever associated with America. Amerigo Vespucci, the third son of a Florentine notary was born March 9, 1451. He studied diligently and became quite proficient in astronomy and in the use of astrolabe, but his principal interest was in a commercial career. He established himself as an agent for the House of Cadiz, and in 1495, after the death of Juanito Berardi who contracted to supply 12 vessels of 900 tons each to the crown of Spain, Vespucci undertook to settle the claims left after his friend's death and to complete the equipment of ships. In 1497, at the request of the king, he joined the expedition to the New World. As he says in his own words, "the king, Don Fernando of Castile, being about to dispatch four ships to discover new lands toward the west, I was chosen to aid in making discovery" (Thacher, 1896, p. 69). He never explained his exact duties aboard the ship, but judging by his previous experience and excellent acquaintance wth commercal methods he probably went as a sort of supercargo to supervise the distribution of food, to weigh the gold, and to keep accurate tally of the crown's share which, according to the royal decree of 1495, was one-third of the total gold obtained by the expeditions. A rather informal description of the first voyage of Vespucci is contained in his letters written in Italian to his friend. The text was later translated and published in Latin.

The expedition sailed on May 10, 1497, from Cadiz and made a landfall, probably off the coast of Honduras in the vicinity of Caba Gracios a Dios. From this point it sailed along the coast, and after a bloody encounter with the natives in the Campeche region the ships reached the province of Lariab. In the Latin translation the place is called Parias, a mistake which caused great confusion and dispute since it lead many to believe that Vespucci referred to the Gulf of Paria off the Venezuela coast discovered by Columbus in 1498 during his third voyage. The informal style of Vespucci's narrative and obscure meaning of several of his statements induced many to believe that his claims were false and that he never even had participated in the voyages he had described (Humboldt, 1837). Others, however, gave him full credit for his achievements. His letters sounded sufficiently convincing to the group of cartographers who worked in the small village of Saint-Di in Lorraine. In about 1507, in recognition of his achievements, they decided to give the name "America" to the continent of the New World (see Martin Waldseemüller map of 1520 and Leonardo de Vinci map of 1512). The controversery about the role of Amerigo Vespucci in geographical discoveries in the New World continued for centuries. Some of his critics of more recent years maintain that Spaniards had never discovered the Gulf which ver

ikely was visited first by the Portuguese captains who landed on its coast shortly before the year 1500. The true role of Amerigo Vespucci in the discovery of the New World probably never will be determined with certainty. It is significant, however, that the so-called Cantino map, executed in Lisbon between December 1501 and October 1502 contained the data which were described by Vespucci in his letters. This chart shows Cuba as an island, and the northwestern continental land is plainly shown from the southern point of Florida to the Hudson River. Likewise, Vespucci's discoveries are clearly depicted by Waldseemüller in a map of 1507 printed in Ptolemy Geography in 1513. As Thacher (1896) states, "Surely some ship sailed to the south of Cuba into the Gulf of Mexico around the point of Florida and well up the northeast coast before the beginning of the sixteenth century. No one ever claimed to have done these things except Amerigo Vespucci."

Tales of fabulous riches in the new land, of gold and precious stones, told by the crews of the earliest explorers upon their return to Spain stimulated feverish activities. During the first quarter of the sixteenth century large numbers of expeditions were outfitted and sailed westward. Science played only a minor part in these undertakings. The governments sponsoring the expeditions were interested primarily in the conquest of new territories, in establishing new colonies, and increasing their revenues by imposing high taxes on gold, silver, and precious stones brought back from the New World. Explorers and adventurers successful in obtaining royal decrees authorizing their enterprise were looking for a quick personal enrichment and glorification. It was customary that each expedition be accompanied by an astronomer cosmographer or cartographer to help in navigation and to record the observations needed for the preparation of maps. The duties of these men were not clearly defined, their work was frequently ridiculed and they suffered from the lack of understanding and even open contempt of the crews.

It is impossible in a brief review, to summarize the results of the principal expeditions which visited the Gulf of Mexico during the first half of the sixteenth century. For the purpose of this paper, it is sufficient to mention that in 1513, Ponce de Leon, after making a formal discovery of Florida, found the Florida Keys which he called Las Islas de los Martires and the Tortugas Islands.

In 1516, Diego Miruelo undertook another expedition to Florida, while Hernando de Cordova and Antonio de Alaminos explored the northern and western coasts of Yucatan and reached Campeche Bay. In 1518, Juan de Grijalva, in command of a force consisting of 4 ships and 250 men, retraced Cordova's route toward Yucatan, discovered Cozumel Island which he named Isla de Santa Cruz, and explored the western coast of the Gulf as far as Panuco. During this expedition the Spaniards for the first time heard the name Mexico applied to this part of the new continent. In 1519, Hernando Cortes, with Antonio de Alaminos as chief pilot, explored the same coast again and established the town of Vera Cruz while Alonzo Alvarez Pineda explored the northern coast of the Gulf and discovered the mouth of the Mississippi River which he called Rio del Espiritu Santo. Ill-fated expeditions of Panfilio de Narvaez in 1527 and of his successor, Cabeza de Vaca, explored the west coast of Florida, including Tampa Bay and the northern coast of the Gulf from Apalache Bay, and Apalachicola River (which the Spaniards called Rio de Magdelena) to the Mississippi River. The largest adventure of this type was the expedition of De Soto who assembled 7 ships with about 700 soldiers and in 1538 sailed from Havana to Florida. The dis-

covery of Pensacola Bay, the convincing evidence that the Mississippi is a mighty stream which drains from a large continent, and the exploration of the northern coast of the Gulf, from Florida to Mexico, were the principal scientific results of De Soto's expedition. The conquest of Mexico by Cortes and the completion of the De Soto explorations marked the end of the period of earliest discoveries in the Gulf.

The Spanish government and the educated portion of the Spanish nation realized the great advantages derived from the possession of the newly acquired territories. Ability and resources to develop them were insufficient, however, but Spain jealously watched the efforts of other powers to establish colonies in America. Maps, astronomical observations, sailing directions, and other scientific products of explorations were carefully guarded. Using the modern expression, it can be said that all scientific data of earlier explorations were "classified." It was forbidden to disclose them to foreign powers. Cartographers and navigators of that time often found themselves in a difficult situation when in possession of material sought by an unfriendly power.

Realizing the importance of new geographical discoveries, the Spanish government formed in January 20, 1503, an office called Casa de la Contratracion de las Indias which functioned as a peculiar combination of the board of trade and a hydrographic office, established with special reference to regulate the commerce and navigation in the New World. The Casa had a separate department of geography and cosmography which was established in 1508 to exercise control over the charting of the newly discovered territories. For this purpose, the government ordered the preparation of a master chart, Padron Real, the completion of which was entrusted to such famous navigators as Amerigo Vespucci, Juan Diaz de Solis, and Vincente Pinzon. Official marine charts were considered of such great importance that they were kept secret, under lock in the coffer with two keys, one for Pilot-Major and one for Cosmographer-Major of the Casa. At the same time, the Spanish government issued an order prohibiting foreigners to hold the rank of pilot or mate on any Spanish ships. These attempts to prevent the dissemination of geographical knowledge confronted the astronomers and cartographers with a predicament familiar, at the present time, to scientists engaged in classified research. By the order of the government, all pilots were enjoined to trace on their charts "every land, island, bay, harbor, and other things new and worthy of being noted," and to turn over the charts to the Pilot-Major as soon as their ships landed in Spain. They could use only official copies of the government charts verified by the officials of the Casa. In this way rigid governmental control was exercised over the publication and sale of charts.

Data turned in by the pilots were not too accurate, the errors being particularly great in the determination of the longitude. As a matter of fact, scientific cartography became possible only in the middle of the seventeenth century when in 1657, Huygens built the first reliable pendulum clock, and this time-keeping instrument together with the telescope were adopted for astronomical observations. The determination of longitude was the weakest part of sixteenth century navigation. Navigational instruments of that time were few and simple. They consisted of an astrolabe, astronomical ring, and cross staff or back staff, the latter being crude forerunners of the modern sextant. The latitude was determined with fairly good accuracy, the error being about 1 degree, but for the determination of longitude the pilot was dependent on dead reckoning made with the traverse board on which the ship's daily speed and course was set. The crude methods sometimes led to fantastic errors and caused many

arguments between the principal maritime powers. The situation became the source of grave disputes when Pope Alexander VI, issued, in 1943, the Bull of Demarcation. The purpose of this masterpiece of diplomacy was to settle claims of the two rivals, Spain and Portugal, by assigning to the first one "all lands not already belonging to any other Christian prince which had been or would be discovered 100 leagues west of the meridian line passing through the Azores," and to Portugal all the discoveries east of this line. The catch was that nobody knew the position of the line.

During the fifteenth and sixteenth centuries, the trade in maps and charts developed as a highly specialized profession. The cartographer was a learned man—proficient in astronomy and navigation and a skillful draftsman. He was also an artist, experienced engraver, and printer. Information needed for the construction of a new map was coming to him from various sources—frequently smuggled from abroad or obtained by other illicit means. His fate was not always a happy one, especially if he permitted himself to get mixed with politics or involved in a controversy about religious dogmas. Mercator, whose name is forever associated with navigational charts and map projection, was one of the foremost cartographers of the sixteenth century who, during the 57 years of map making, perhaps did more than any other man to elevate cartography from a low art to the position of exact science. One of his maps made in 1538 for the first time applied the name "America" to both the North and South American continents. In 1544, he hardly escaped from being burned at the stake when, by the order of the Regent Mary, Queen Dowager of Hungary, he was seized as an heretic, and with 43 others condemned to death. The campaign against Lutheran heresies at that time was conducted with such violence that the only restraint against wholesale slaughter was the consideration that the provinces should not be entirely depopulated. Men of science had to watch their words and actions very carefully in order to avoid the clutches of the inquisition. The conditions under which they worked remind us of the present situation of thousands of scientists laboring behind the Iron Curtain and forced, under the continuous threat to their lives, to conform their findings to the principle of Marxian doctrine as interpreted by the politbureau in Kremlin.

The position of a cosmographer or astronomer attached to various expeditions was a peculiar one. The undertakings were of a definitely military nature. Large forces, sometimes comprising several hundred foot soldiers and horsemen, were assembled. Ships were loaded with weapons, food, various supplies, and sundry materials for establishing colonies. Large dogs, mostly greyhounds and mastiffs, trained for battle, were taken in large numbers and used in fighting the Indians and guarding camps. In the conquest of the New World, these dogs accomplished great feats and won the admiration of Spaniards, who recorded in their annals the names of the most celebrated animals. The greatest strength of the invaders consisted, however, in horses. The sight of an unknown, large animal, protected by heavy leather covering which extended down to its knees and mounted by heavily armed horsemen, was terrifying to the Indians until they learned the technique of incapacitating the horses by shooting arrows into their knees. The effect of cavalry attacks on Indians during these expeditions was probably similar to the effects of first attacks of tanks on the army entirely unprepared to oppose the new weapon. From the commentaries of Cabeza de Vaca or from the history of the De Soto expedition written by Garcilaso de la Vega so-called "The Inca" we learn about the efforts of the men who while participating in the military

operations at the same time were engaged in astronomical observations, surveyed the coast, and recorded the nature of the country, listed its plants and animals, determined its suitability for colonization, and described the customs of its natives. Frequently these duties were combined with the functions of a government representative assigned to the expedition. Thus, the De Soto expedition was accompanied by Juan de Añasco who as a comptroller of His Majesty Imperial Exchequer was looking after the interests of the Spanish treasury. According to Gracilaso, he was also a "cavalier," a great mariner, cosmographer, and astrologer." He brought back documented reports regarding the coastline, harbors, anchorages, and observations on mineral riches, and fertility of the country. How little support this man received from his companions may be judged from an incident described by Gracilaso. Toward the end of the De Soto expedition, after the death of its leader and the loss in fire at Mobile of all the instruments for navigation, the survivors managed to build several small canoes in which they escaped from the pursuing Indians. After leaving the mouth of the Mississippi River, they sailed westward, traveling near the coast. Añasco, being a resourceful man, managed to salvage an astrolabe which because it was made from metal was only slightly damaged by fire. From a parchment of deerskin he made a sea chart, and with a ruler, he constructed a forestaff. These crude instruments were of great help in guiding the boats, but his companions ridiculed him so for his efforts that in disgust he threw all the instruments overboard.

Sometimes the expeditions were accompanied by artists who made pictorial records of the country and its people. Probably the most interesting documents of that type were made by LeMoyne in 1564, an artist who accompanied the French expedition to Florida under Laudonniere. Fortunately, the original drawings depicting the life of Florida Indians, excellently reproduced in 42 heliotypes published in 1825, are now available for study together with the translation from the original Latin text.

Records of the ealiest explorations of the Gulf open up an interesting picture of a slow and uncertain progress of scientific research conducted under the most difficult conditions by men of great determination and unfailing energy. Bits of scientfic knowledge gained during these efforts, scattered and unsystematized as they were during the first half of the sixteenth century, eventually were brought together and correctly evaluated. They helped to form a sound basis of the present geography of the Gulf. The cosmographers and explorers of that time often found themselves in the possession of information which was of great inportance to the government and the disclosure of which to a foreign power would be regarded as treason. As at the present time, the attempts to keep scientific data confined to state boundaries completely failed proving that they cannot be kept secret indefinitely. In studying the records of the earliest explorations, one cannot fail to have high respect and admiration for the explorers and scientists of the old time whose determination and resourcefulnes laid the foundation of our present geographic knowledge.

The Activities of the Gulf States Marine Fisheries Commission, October 1950 - October 1951

W. Dudley Gunn, *Secretary-Treasurer*
Gulf States Marine Fisheries Commission

Foreword—The marine fisheries compact, entered into by the states of Alabama, Florida, Louisiana and Texas in July of 1949 and Mississippi in January of 1950, continues to attest in a high degree to the value of such interstate organizations. Until the formation of the Gulf States Marine Fisheries Commission there was no interstate fishery organization representative of the five Gulf states. The lack of this central coordinating medium is a principal reason for the long delay by the federal government in authorizing offshore programs of fishery explorations and research. Also, prior to the signing of the compact, no medium was available to the states for joint interstate action designed to lead to the better management of the coastal fisheries.

State Fishery Programs— Added impetus to existing fishery programs and the developing of new programs is now in evidence in all states. Money derived from the sale of dead oyster and clam shells provide most of the funds being made available by the states for expanded research and reclamation work.

All states participated in oyster reef restoration during the past year. In Alabama, Mississippi and Louisiana, development of the oyster fisheries will continue to be the chief objective for the year 1951-52. In Florida and Texas the oyster programs will be supplemented, with the former state continuing studies of the mullet and other species and carrying on both biological and technological work on Key West Brazilian shrimp, and Texas progressing the ecological survey of the 135 mile long Texas Laguna Madre, along with fin and shellfish studies.

Reciprocal Fishery Agreements—During the past year Alabama and Mississippi completed a reciprocal shrimp agreement. Alabama and Florida completed such an agreement several years ago, as well as did Louisiana and Mississippi. The Louisiana legislature has not made any changes in existing laws on the subject of reciprocal agreements. It is possible that the next regular session of the Louisiana legislature, meeting in May of 1952, will give the matter consideration. In Federal District Court, per decree entered August 20, 1951, certain sections of the Louisiana Revised Statutes of 1950 were ruled unconstitutional, insofar as they affect non-resident fishermen and non-resident fishing boats. Motion has been filed for a new trial, which his now pending. Texas does not have reciprocal fishery agreements with any state. Such authority was not extended by the 1951 Legislature. Texas waters are now open to fishermen of any state with the paying of a nominal annual boat license of $6.00 plus $3.00 per fisherman plus $15.00 trawl license. Litigation in Texas was decided some months ago by courts in that state in favor of non-resident fishermen on the same issues as have been raised in the currently pending Federal Court case in Louisiana.

Shrimp Study—Commission Informational Bulletin No. 1 was issued May 5, 1951 and directed to the legislators and marine fishery administrators of the several states for such consideration as might be deemed appropriate in the development of laws and regulations pertaining to the shrimp fishery of their state. A comprehensive report of the reaction to the suggested regulations will be available within the coming year. As more scientifically sound

information becomes available, such data will be passed to the proper state authorities.

Shrimp Importations—Two schools of thought have developed in the shrimp industry, with one continuing effort for federal legislation to limit imports, and the other having assumed a passive attitude with regard to imports legislation but having entered into an association with Mexican interests to promote consumer consumption of shrimp. At the second annual meeting of the Commission, Biloxi, Mississippi, October 18-19, 1951, the Commission and representatives of industry present agreed on the need for an impartial survey of the shrimp industry as a possible solution to conflicting thinking in terms of limiting the volume of shrimp imports.

Inshore Oceanographic Survey—Through the cooperative effort of the several Gulf States and the Fish & Wildlife Service, the Commission hopes to see the initiation of an inshore oceanographic survey during the year 1951-52. Such a survey of the coastal bays and estuaries would complement and supplement a project of this nature which is now being progressed by the Fish and Wildlife Service in the open waters of the Gulf.

Marine Fisheries Student Education—The Commission has gone on record as favoring an educational program to be directed toward familiarizing the younger generation with matters relating to the marine fisheries, the same to be channelled through science teachers of coastal graded schools in each of the compacted states. Preliminary work is now underway and it is hoped by the summer of 1952 such teacher courses will be made available in selected areas of each state.

Monthly State Landing Records—Four of the five Gulf States are publishing monthly landing records, in cooperation with the Fish & Wildlife Service. These records are continuing to show improvement. 1951-52 publications are expected to show additional information, such as; area of catch, (particularly shrimp); further breakdown of edible and non-edible fishes; and, attributable reason for production fluctuations such as normal seasonal weather, economic, or others.

Gulf Exploratory Fishing Program—The Commission voted at its second annual meeting not to request the Fish and Wildlife Service to make any changes in the current program of explorations until the Gulf waters have been completely explored for shrimp and a comprehensive report rendered as to conclusions. The present exploratory program coordinated with the Fish and Wildlife Service at a meeting in Mobile, Alabama, July 1950, involves the three species, shrimp, tuna and snapper, with shrimp receiving primary consideration.

It is expected that exploratory efforts will be directed in the months immediately ahead toward the perfection of gear necessary to capture Brazilian shrimp known to exist in the offshore areas between Cedar Keys and Fort Myers, and in which area the loggerhead sponges have been a deterrent. Initial explorations for Brazilian shrimp in the offshore area lying between Apalachicola and Choctawhatchee Bays indicate the desirability for further study. Additionally, further effort to locate concentrations of the scattered Brazilian shrimp off the coast of Texas is anticipated. The growing demand for further knowledge of the widely dispersed red shrimp warrants additional explorations.

The appearance of tuna in large schools in the deeper Gulf waters, in all directions from the mouth of the Mississippi River in the late summer of this year, points to the possibility of developing a Gulf tuna hatchery.

Explorations and gear development studies involving the red snapper are expected to continue.

Gulf Biological Program—The research vessel *Alaska,* sister ship of the exploratory vessel *Oregon,* since going into service in April 1951, has completed three cruises in the Gulf. The vessel has covered 7,000 miles of Gulf water and has occupied 125 stations. During the cruises 1156 salinity determinations were made. Plankton tows have resulted in a considerable number of fish eggs and larvae being collected. Identification is progressing slowly because of the relatively small amount of information available on the life history of the Gulf fishes. Water fertility analyses, phosphates and nitrates, have been run on 371 samples. Early determinations point to highest concentrations inside the 100 fathom curve. Initial observations suggest the possible occurence of more fish within the area of the continental shelf than in the deeper waters beyond.

Red Tide Investigations—The sampling over a prearranged series of stations extending from the rivers to the 100 fathom contour in the vicinity of Boca Grande for a study of the local oceanography, nutrients and plankton has been completed. The data collected are now being analyzed. One tentative conclusion is that the phosphate content of the waters examined in the same order, is in agreement as that of waters of the Gulf as a whole, as shown by the work of the *Alaska.*

All plankton collected during the past year has been examined and the data resulting are being set up on punch cards for analytical studies.

A recent small scale blooming of dinoflagellates in the Indian River section of Florida provided a testing ground for some of the newer ideas on plankton blooms. Culture studies on the nutritional requirements of dinoflagellates and other marine organisms have been continued at the Service's Beaufort, N. C. laboratory.

Gulf Oyster Investigations—In brief, the purpose of the Gulf Oyster Investigations is to find out how to produce more and better oysters with the most economical expenditure of time and money. To achieve this end, efforts have been progressed in several directions simultaneously. These different approaches to the problem include an understanding of the following:

The annual reproductive cycle of the oyster in the Pensacola, Florida area; the growth pattern of the oyster in relation to the maximum yield of meat; the importance of parasites and predators in oyster mortalities; and, methods of improving the quality of the laboratory stock of oysters.

Several of the individual units of research which make up the program of the Gulf Oyster Investigations have been brought to a conclusion. These results are in the process of analysis and will appear in manuscripts which are now being prepared. In 1952 approximately 65 per cent of the Pensacola Laboratory's time will be spent on continuing projects such as the seasonal study of the oyster in relation to environmental change and the work on genetics of the oyster. By the spring of 1952 it is estimated that 30 per cent of the research time will be available for the initiation of new studies. Much of this available time will be devoted to a more exhaustive study of methods for trapping and otherwise controlling the oyster drill.

Activities of the Atlantic States Marine Fisheries Commission

WAYNE D. HEYDECKER, *Secretary-Treasurer,*
Atlantic States Marine Fisheries Commission

In a report last November, the results of the controversy over the language of the enabling act to implement the International Treaty on the Northwest Atlantic Fisheries were summarized and it was pointed out how essential it is, in connection with any future treaties, that ratification of the Treaty be contingent upon the simultaneous passage of satisfactory implementing legislation adequately protecting state jurisdiction. While it is true that the enabling legislation finally adopted with respect to the Northwest Atlantic Fisheries does preserve current state jurisdiction, the result was achieved only after much effort and expense, which could have been avoided had ratification and implementing legislation been adopted at the same time.

On December 12, 1950 it was the writer's privilege to present to the Association of Attorneys General, meeting in this city a joint paper, with Special Advisor, Frederick L. Zimmerman, entitled "Impact of Treaties on the Conservation Laws of the States." In that paper attention was called to the importance of protecting the states by simultaneous action on a treaty and its enabling legislation. It is hoped that the procedure recommended may become the practice in the future.

During the past year much time and effort has been expended on the Pollution Study Project. Copies of tentative draft reports covering 14 of the 15 states along the Atlantic Coast were mimeographed and distributed for criticism and correction to the Commissioners, state, health, and fishery officials, interstate sanitation agencies, the U. S. Fish & Wildlife Service, and the U. S. Public Health Service. These covered past efforts by the states to identify, evaluate and correct sources of pollution, particularly industrial pollution, that harm or threaten to harm the marine fisheries. As corrections come in, these are being incorporated and redistributed to all who received the tentative drafts. Whether these reports will be published or simply kept as office records by the cooperating agencies has not yet been decided.

Meanwhile, the small Project staff is working on Phase 2 of the Project which is concerned with the estimation of the value of the fisheries affected by industrial pollution and the calculation of the annual monetary loss resulting therefrom.

In the North Atlantic Section, Maine is studying the lobster, sampling the size and composition of the commercial catch, the damage done by the marine borer, the effects of the infestation of lobster pounds by red tail, and the use of artificial sea water for keeping lobsters alive for inland shipment. The clam investigations, originating in the North Atlantic Section of the Commission and financed by Congressional appropriations, are continuing to develop scientific data on which to rest a program of rehabilitation. Wire fences have been found effective against the predator, horseshoe crabs, but not against small green crabs, or the drill, Polynices. Spawning and setting studies have been made as part of the study on the practicability of clam farming. Studies of the mass mortality of 1949 suggest minute parasites as a possible cause. The subject is exceedingly complex and numerous studies must still be made before a sound conservation program can be evolved.

Studies on the Atlantic salmon are continuing. Maine is also studying the

sea scallop, herring and smelt. Two new Fish & Wildlife Service projects financed by Congressional appropriations with the endorsement of this Section and the Commission are now in operation. These are freezing in the round at sea and exploratory fishing for tuna, the latter operating in two units, one in the north, the other in the south. The freezing project operates out of East Boston with the former trawler *Delaware,* recently refitted with specially designed quick freezing equipment. The northern unit of the exploratory fishing project also operates out of East Boston with a chartered vessel. The southern unit is operated jointly by the Fish & Wildlife Service and the Blue Channel Corporation of Beaufort, S. C. Both projects have been experimenting with different types of gear and have been scouting their respective areas to determine if tuna fish or marketable size and quantity are to be found therein.

The shad investigations sponsored by the Commission cover the coast but are currently concentrated in the Middle Atlantic Section, particularly in the Hudson River which has been used as a pilot study. Operations, however, have been wide. The Service has just issued two reports "A Survey of Former Shad Streams in Maine" and "Fishways that Shad Ascend." Next year efforts will be concentrated in Delaware River and Bay and in Chesapeake Bay. Meantime, some work has been done in the Merrimack, Connecticut, Delaware, Susquehanna, and various Georgia Rivers and in Winyah and Chesapeake Bays.

The Middle Atlantic Section is still trying to bring about closer cooperation between New Jersey and Delaware with respect to fishery laws of Delaware Bay. New Jersey recently modified its "no netting law" with respect to striped bass to permit the retention of legal sized striped bass caught in licensed shad nets during February, March and April. Funds for fisheries research have been voted by Delaware and a laboratory has been set up at Lewes, in cooperation with the University of Delaware. One excellent example of federal-state cooperation is the appropriation of $20,000 by the Commonwealth of Pennsylvania for a joint study with the Fish & Wildlife Service of the migration of shad in the Susquehanna River in connection with the overall shad study now under way by the Service.

The Chesapeake Bay Section has held three meetings during the past year and one is scheduled for December 5. Some progress appears to have been made by Maryland and Virginia toward a solution of their joint problems in the Potomac River, but no proposals have yet been formulated. Meanwhile, in spite of insufficient funds, cordial cooperative effort continues among the two state laboratories and the Fish & Wildlife Service in their joint studies of blue crab, croaker, and shad.

With North Carolina participating, the Chesapeake Bay States, Maryland and Virginia, recently investigated charges that shrimp fishing operations in Pamlico Sound were damaging the croaker stocks which are important to Maryland and Virginia fisheries. A special technical advisory committee comprised of representatives of the fishery laboratories of Maryland, Virginia, North Carolina, South Carolina, and the U. S. Fish & Wildlife Service on November 1, 1951 at Baltimore, reported to the Section that there is no evidence that shrimping operations in Pamlico Sound adversely affect the croaker fisheries of Maryland and Virginia. They further reported no proof of interchange of croakers between the two areas but recommended further study to discover causes of recent declines in croaker production in the two areas and studies of migration, etc. Until such studies reveal a need

therefor, they also recommend no restrictions on the Pamlico Sound shrimping operations.

The South Atlantic Section at its meeting in New York, September 7, voted to recommend that each of the four states in the Section impose on out-of-state boats the same license fee as is charged for in-state boats. This will be a long step forward in interstate cooperation if the recommendation is accepted by the legislatures of the four states. The states will still have to determine the conservation regulations to be applied to the "inside waters" in bays and sounds and the "outside waters" of the maritime belt. That these regulations may differ has long been established. A special committee of the whole Commission is now being organized for the purpose of determining in what ways the U. S. Supreme Court decision in *Toomer v. Witsell* permits proper variations in treatment of out-of-state licenses in their operations in these different waters.

The joint federal-state program for fishery research in the South Atlantic Section initiated by the Section two years ago has lagged for want of both state and federal funds. Some federal funds are now available. The Section met on November 12 and a committee of state and federal scientists met again on Nov. 13 for the purpose of discussing these problems. Until their conclusions are made public, little more can be said on this point. One thing is already evident. It would clearly be to the advantage of South Carolina, Georgia, and Florida to adopt Amendment No. 1 to the Atlantic Fisheries Compact. This amendment would permit two or more states having an interest in a common fishery to act jointly through a special section of the Commission. The Amendment has been adopted by Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey, Pennsylvania, and North Carolina and consented to by the Congress. It might be very useful in handling a joint problem like the management of the South Atlantic shrimp fishery.

The Atlantic States Marine Fisheries Commission has now completed ten years of existence. Much has been accomplished by the cooperating states in that period; much is still in process and much remains to be done. The concept of the Compact under which the Commission functions is that of a long term continuing operation. The Commission is an advisory body only. The achievements that flow from it are those of its member states.

The Effect of Fluctuations in the Availability of Sharks on a Shark Fishery

STEWART SPRINGER, *Pascagoula, Mississippi.*

From 1936 to 1950 the shark fishery of south Florida operated continuously, except for a break of a few months in 1939 and 1949 due to overproduction. Records of the catch at the Salerno fishing station were made as a standardized routine from the beginning of January 1938 through December 1946, for use by the original station operators, Shark Fisheries, Inc., and its successors, Shark Industries, Inc., and Shark Industries Division of the Borden Company. Information on the number, size and kind of sharks in each catch was recorded daily on a standard form which was used as a basis for weekly payments to fishermen, and, along with other information

as a basis for cost accounting and management of the fishery. Credit is due to the late Robert M. French, President of Shark Industries and subsequently president of Shark Industries Division of the Borden Company, that methods of recording were set up properly and were continued for a long enough period to give the company useful information for the management of the fishery.

Some estimates of production can be made for the period prior to 1938, but no records remain. Records of total landings and total amounts of gear in use are available for 1947, 1948 and 1949 but these records do not have catches recorded by species. The fishing operation was discontinued early in 1950, due to the appearance of low cost synthetic vitamin A on the market.

The shark fishery of the southeastern states was never large. The maximum number of boats in use at Salerno at any one time was five and the greatest number known to have been operating off the entire coast of the southeastern states at one time was sixteen.

The catch per unit-of-effort is defined for this report as the number of sharks caught on 100 baited hooks, set for a minimum of eight hours, and *availability* is used as a term to be derived from catch per unit-of-effort data. The use of *relative apparent abundance* has been suggested by Marr (1951) as a term for the concept of a population to be derived from catch per unit-of-effort data. This writer also points out that standardization is not essential if workers define their terms. His terminology is used in this report.

The Fishery Area And Methods—1938-1946

The fishing grounds of the Salerno station extended from the vicinity of Jupiter, about 12 miles south of the station, to Bethel Shoal, about 35 miles north. From 1938 through 1946, all fishing was carried on with chain set lines, except for short periods in some summers when one boat set gill nets for nurse sharks close inshore. The chain set lines were used in lengths up to 1 mile, with hooks on chain leaders about six feet long, the leaders being permanently attached to the main chain about 25 feet apart. Ordinarily one boat set two lines with 100 or more hooks each, baited in the afternoon and pulled the following morning. Each end of the chain line was rigged with the anchor, attached to a buoy. Because of the weight of the chain it was often impractical to fish in depths greater than 25 fathoms, although a few sets were made in depths as great as 50 fathoms when currents were not strong. A number of improvements in the chain rigs were made between 1938 and 1946 but these were primarily improvements to permit easier handling. Probably these improvements did not greatly affect the catch per unit-of-effort since it is defined here as the catch per hundred hooks. Improvements in the gear and the development of special wildcats for pulling chains, some operated electrically and some with hydraulic controls, had the effect of reducing the number of boats and men required to set the same number of hooks and substantially increased the earnings of the fishermen. In 1938, four boats were in operation through most of the year but the number was gradually decreased through part time operation of some boats, so that after 1946 only two were in regular operation and these fished in the Salerno area only a part of the year.

The policy of the station operators limited the amount of fishing effort in the area. Fishermen were furnished boats, gear, fuel and bait without charge. Catches were purchased at a fixed rate for each shark having a hide length of 55 inches or more. In the later part of the period between 1938 and 1946

an additional amount (bonus) was added for any shark twelve feet or more in total length. Also, in the later period, a bonus was paid for high production. However, at least until after 1946, no special inducement was offered for catching a particular kind of shark and all kinds of sharks were bought at the same rate. Under these circumstances the fishermen preferred to catch the sandbar shark, *Eulamia milberti,* because in the Salerno area the species almost always had a hide length of 55 inches or slightly more, and the amount of labor in handling it was less than for other species. From the point of view of the fisherman, the objective was to get as many sharks as possible, regardless of kind, and if there was any practice that was selective it was in favor of the sandbar shark. It seems doubtful, however, that fishing was appreciably selective of species from 1938 through 1946. No carcasses were ever dumped overboard off Salerno regardless of their condition because it was the belief of the fishermen that shark carcasses dumped on the fishing grounds caused sharks to stop biting.

Heads, small sharks and badly damaged carcasses were brought in, although these were not counted in reports. In a number of instances seines, gill nets, float lines and other kinds of gear were tried for catching sharks at Salerno on an experimental basis. Catches from these sources are not included in the figures shown in the tables.

Until 1946 the bait furnished by the station was any kind of fish available. The fish were often iced and were as fresh as possible. Jacks (*Caranx hippos*) and little tuna (*Euthynnus alleteratus*) weighing more than two pounds each were preferred by the fishermen and were generally supplied. The bait, whether frozen or fresh, was cut to approximately one pound size at the time of use. Before 1947 almost all trips began at or before dawn and the boats returned with catches in the afternoon. Neither mechanical refrigeration nor ice was used.

The trends of fishing success at Salerno are shown in Table 1 by the catch per unit-of-effort for all species. It will be noted that there is a cycle in apparent availability, with a peak every three years, and that this cycle is more clearly shown for one species, *Eulamia milberti,* in the partial breakdown by species. In combination, the first three year period, (1938-1940), has a catch per unit-of-effort value of 6.00, the second three year period 5.45, and the third period 6.09.

There are a number of conditions that may have had some effect on relative availability of sharks during the period from 1938 through 1946. It does not seem possible to assess their comparative importance and it is likely that only some of the more obvious ones have been noted. However, each of the following conditions have affected production in one or more years.

The year 1937 before these records begin, was said to have been a year of very good catches. It was characterized, however, by a remarkable run of *Carcharhinus leucas,* the bull shark. This species was relatively much less common in the southeast Florida area for the following 12 years. The bull shark is probably the most important predator on young or small sharks when it is common, and the 1937 run may have reduced the number of young sharks of that year.

The Salerno fishing in 1940 was discontinued after August. Table 2 shows that this eliminated production in the quarter of the year with the poorest catch rate and this should have contributed to the peak catch rate recorded for the year. Nevertheless, the last quarter of the year 1940 was an unusually

TABLE 1

LANDINGS AT SALERNO, FLORIDA SHARK FISHING STATION
(Combined Figures For Each Three Year Period Are Given in Parenthesis)

Number of sharks All species Total landings	Number of units[1] of-effort Totals for year	Catch per unit-of-effort All species	Year	*Eulamia milberti* catch u/e	*Eulamia obscurus* catch u/e	*Carcharhinus leucas* catch u/e	*Galeocerdo* catch u/e	*Sphyrna* All hammerheads catch u/e
5017	1099	4.57	1938	2.02	.67	.52	.45	.17
6754	1154	5.85	1939[2]	3.99	.69	.15	.28	.15
4870	519	9.38	1940[3]	6.86	.85	.23	.23	.34
(16,641)	(2772)	(6.00)		(3.75)				
4360	896	4.87	1941	2.59	.98	.14	.14	.28
3628	724	5.01	1942	2.78	1.08	.19	.19	.33
4836	731	6.61	1943	4.27	1.05	.11	.12	.41
(12,824)	(2351)	(5.45)		(3.17)				
3209	851	3.69	1944	1.90	.54	.16	.16	.26
7626	1106	6.90	1945	3.90	.96	.17	.37	.59
9426	1372	6.87	1946	4.19	.68	.11	.32	.37
(20,261)	(3329)	(6.09)		(3.52)				
10,514	1345	7.82	1947					
9283	1076	8.63	1948					
9047	944	9.10	1949					
(28,844)	(3365)	(8.57)						

Catch records by species not available for this period. A major change in gear and methods permitted greater depth range for fishing.. Fishing at Salerno not continuous for all months of the year.

[1] Unit of effort is defined as 100 baited hooks set for a minimum of 8 hours.
[2] Fishing discontinued after August.
[3] Fishing carried on for five months only, April through August.

TABLE 2

SALERNO SHARK LANDINGS, BY MONTHS FROM 1938-1946

Month	Number sharks landed	Number of *Eulamia milberti* only	Total units-of-effort	Catch per unit-of-effort *Eulamia milberti* only	Catch per unit-of-effort
January*	3859	2213	561	3.9	6.9
February*	3893	2601	544	4.8	7.2
March*	4027	2591	626	4.1	6.4
April	5936	3928	948	4.1	6.3
May	7901	5227	1234	4.2	6.5
June	8651	4645	1356	3.4	6.4
July	7224	4231	1278	3.3	5.6
August	3570	1518	848	1.8	4.2
September**	1075	349	312	1.1	3.4
October**	745	277	148	1.9	5.0
November**	1154	538	289	1.9	4.0
December**	1691	966	308	3.1	5.5

*No fishing in these months in 1940
**No fishing in these months in 1939 and 1940

good shark fishing period in the Florida Keys as shown by some catch records at Lower Matecumbe, and was followed by such poor fishing in 1941 that a relatively large shark fishing operation begun at Matecumbe in 1940 was discontinued the following year.

An examination of the hide records for 1940 indicates that there may have been a summer run of silk sharks, *Eulamia floridanus*. These may have come closer inshore than usual, with the result that they were picked up on the chain set lines. Since this species and some other common Salerno sharks had not been described in 1940, and since the forms that had been provided for recording landings did not list any species not known to biologists, there were occasional "force fits" of catches to the recording forms, even though the fishermen and dock workers recognized the undescribed species as distinct kinds of sharks.

There was some reduction of fishing intensity at Salerno during the war and fishing boats were restricted to daylight operation. Probably this did not affect the catch per unit-of-effort. However, difficulties in procurement of good hooks and other gear and the loss of some experienced fishermen to the armed forces and to other fisheries probably adversely affected the rate of catch.

In late 1945 and in all of 1946 new boats and new equipment were being prepared. Production was not discontinued but a substantial part of the Salerno fishing was carried on by relatively inexperienced men.

CHANGES IN GEAR AND METHODS—1946 THROUGH 1949

The sharks landed at Salerno were processed there and any portion of the production not utilized as liver oil, dried fins, hides, or fresh or salted shark meat was made into meal. The processing operation not only required certain minimum landings to be profitable, but was practical only if landings were to some extent predictable.

Had the catch per unit-of-effort remained at the average for each year or had it declined or increased gradually, it is probable that no determined attempts would have been made by the management to improve the situation

The effect of the irregular production was so serious on the flow of material to the processing plant that a program was started in late 1944 to increase the production at predictable times. It was felt that this could be done by increasing the depth range of the fishing, extending the range of the fishing boats somewhat, and by bringing some of the information shown in the statistical summaries to the attention of the fisherman. The program involved the use of new boats and equipment for fishing, the availability of frozen bait, and the use of mechanical refrigeration on the boats. The program was not all put into effect at one time and some of the changes in gear were initially unpopular with the fishermen. Nevertheless, at the beginning of 1947 the depth range of the fishery was expanding and the records show that the catch per unit-of-effort for the last three years increased 46 per cent over the mean rate for the preceding nine years.

Production increases of this magnitude were not apparent in shark fishing operations in other areas in 1947 and in the opinion of the writer the increase does not reflect any important increase in the abundance of sharks in the Salerno area. It does not seem possible to point to any particular part of the program as being the only instrumentality for the production increase. New boats, larger and better equipped, were in use in late 1945. The use of cable set lines instead of chain set lines permitted fishing in deeper water, up to 200 fathoms, but one of the Salerno boats still used chain gear at the beginning of 1950. At the beginning of 1947 the co-operation between the fishermen was improved. Also the liaison between the fishermen and the shore establishment on fishing problems was much closer. To give fishermen an interest in the fleet's production, a bonus arrangement for high production in any calendar month was established. The bonus was calculated on the basis of total landings of all Salerno shark fishing boats, and this encouraged greater exchange of knowledge between boat captains and stimulated production.

Summary

1. The availability of sharks off Salerno, Florida, as shown by the catch per unit-of-effort, fluctuates in a 3 year cycle. (Data over a period of 12 years.)

2. A breakdown of the data by species for the first 9 years of a 12 year period shows that this fluctuation reflects only the availability of the most abundant species, *Eulamia milberti,* the sandbar shark.

3. During the period of 12 years of managed and limited fishing at Salerno there was no indication that fishing pressure affected the availability of the most abundant species (*Eulamia milberti*) since year to year increases and decreases in the catch per unit-of-effort occurred independently of the intensity of the fishery.

4. Since recurrent bad years threatened the existence of the fishery, a program of operation was worked out on the basis of data on previous catches. Changes in equipment and methods and in fleet management were accompanied by an increase of 46 per cent in catch per unit-of-effort for the last 3 years of a 12 year period although the effect of the three year cycle remained notable.

5. Cooperation between parts of the fleet appeared to be a factor of importance in raising the catch per unit-of-effort as well as cooperation between fishermen and the shore establishment in one proper utilization of improved gear.

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